Quarterly Report

of Selected Research Projects

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Contents

Contact the scientists listed for further information on each research project. For general questions about this report, contact Hank Becker, ARS Information, 5601 Sunnyside Avenue, Beltsville, MD 20705, (301) 504-1624, hbecker@asrr.arsusda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact ARS Office of Technology Transfer, 5601 Sunnyside Avenue, Beltsville, MD 20705-5131. Questions about a company's product and/or research should be directed to the company itself.

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Into the Marketplace

CRADAs

...With Soil Technology, Fallbrook, CA, to test combinations of an enriched compost, a plastic mulch and beneficial microrganisms as possible alternatives to sterilizing strawberry fields with methyl bromide fumigant before planting. Methyl bromide kills soil-dwelling pathogens and weed seeds but is being phased out in the U.S. because it is thought to deplete the Earth's protective ozone layer.

In experimental plots at research and commercial strawberry fields in California, ARS scientists and Soil Technology colleagues will test a plastic mulch and a compost enhanced with organic acids, enzymes andbeneficial microorganisms and combined with corn gluten meal and mycorrhizal fungi.

The growth and health of strawberry plants on plots with the compost, mulch and microbes will be compared to those of plants on plots sterilized with standard amounts of methyl bromide or methyl bromide plus chloropicrin. Strawberry growers are leading users of commercially produced methyl bromide.

The average American eats about five pounds of strawberries in a year. The fruit is fat-free, low in calories and a source of vitamin C, folic acid, potassium and fiber. The 1998 crop of 869,350 tons was worth more than $1 billion to U.S. growers.

Crop Improvement and Protection Research Unit, Salinas, CA
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...With DeKalb Genetics Corp., DeKalb, IL, to evaluate 50 experimental corn hybrids as a source of resistance to aflatoxin, including some developed by DeKalb from germplasm released by ARS. Contamination of corn grain with aflatoxin, a toxin produced by certain fungi, is a major food and feed safety problem. Currently, no aflatoxin-resistant corn hybrids are available to farmers.

Corn with levels of aflatoxin greater than 20 parts per billion is drastically reduced in value because it is restricted from interstate commerce. Aflatoxin is a sporadic problem in the Corn Belt and a chronic one in the South. High levels of aflatoxin in corn harvested in 1998 in Mississippi, Louisiana, Texas and other southern states—together with increased corn acreage in the South—have underscored the need for resistant hybrids. Last year's high aflatoxin levels were due in part to higher-than-usual temperatures and severe drought.

ARS will evaluate the hybrids for aflatoxin resistance. DeKalb will evaluate the hybrids for yield and other desirable agronomic qualities. The objective of the CRADA is to expedite the commercial availability of aflatoxin-resistant hybrids to U.S. farmers.

Corn Host Plant Resistance Research, Mississippi State, MS
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....With DeKalb Genetics Corp., DeKalb, IL, to evaluate corn hybrids that possess both natural and bioengineered sources of genetic resistance to the fall armyworm. The fall armyworm is a serious pest of corn, especially late-planted corn in the South. New commercial hybrids with greater resistance to the pests could reduce farmers' production costs and increase profits.

In lab and field studies, ARS researchers evaluated worm-resistant and worm-susceptible hybrids developed by DeKalb.

The company used germplasm that ARS developed and released as a source of the natural resistance in their hybrids. They added the *Bacillus thuringiensis* (Bt) genes to both susceptible and naturally resistant hybrids. The genes command cells to produce a worm-killing protein.

In research with DeKalb, ARS scientists found that combining Bt and natural resistance resulted in less damage to worms than using either Bt or natural resistance alone. Fall armyworm larval survival and growth were reduced in field tests and laboratory bioassays.
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...With IPM Technologies, Inc., Portland, OR, to develop low-cost, environmentally safe, synthetically based chemicals for trapping crop pests. These chemicals mimic insect scents called pheromones. In ARS laboratory and field experiments, lures containing a special blend of pheromones to attract cabbage looper and beet armyworm moths—laced with a minute quantity of insecticide—successfully drew the pests to their death. This suggests that attract-and-kill lures can control these and probably other insect pests in the field on a large scale.

Attract-and-kill lures reduce pesticide sprayings to control crop-feeding insects because they target only pests. Lures also help save beneficial insects that would normally be killed with area-wide pesticide spraying.

The insects targeted—fall and beet armyworm, cabbage looper, diamondback moth, tobacco budworm and corn earworm—are among the most destructive U.S. crop pests. Corn earworm and armyworms attack a wide variety of crops, including cotton, corn, sorghum, peanuts, lettuce, tomatoes and peppers. Other pests such as the diamondback moth and cabbage looper are more limited in the range of plants attacked, but they can totally destroy crops such as cabbage, collards and broccoli.
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License

... To Spectrum Electrostatic, Inc., San Antonio, TX, to make and sell ARS-patented nozzles for an aerial spray system.

The system is designed to reduce crop production costs by reducing pesticide spray drift. With the nozzles and electrostatically charged chemicals, the prototype system demonstrated reduced pesticide spray rates while providing good insect control against whiteflies and boll weevils in cotton.

Other benefits of the aerial spray system: a time-saving and safe operation with less risk to the applicator and the environment.
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Patents

An anticancer drug, taxol, could become more plentiful in the future, thanks to a new process for mass producing this and related compounds called "taxanes."

Taxol, known generically as paclitaxel, is a potent chemotherapy drug for breast, ovarian, lung and other cancers. But its natural plant source, Pacific yew trees, is scarce, and current extraction procedures cannot provide enough paclitaxel to meet demand. About 6,700 pounds of yew tree bark are needed to produce a pound of the drug.

ARS scientists invented the new process with colleagues at Washington State University and the Cornell Research Foundation, Inc., Ithaca, NY. ARS has applied for patent protection on the new process, which uses lab-cultured yew cells to produce paclitaxel and other related taxanes that can be used for taxol semi-synthesis.

The team used the process to screen multiple cell lines of all five known yew species for their ability to produce paclitaxel. They also developed a technique for using a compound called methyl jasmonate to greatly increase paclitaxel yield from the cell lines.

With this technique, scientists and industries working on plant cell culture processes will be able to identify and select more productive yew tree cell lines.

Medical use of the new tissue-derived source of paclitaxel would require approval from the U.S. Food and Drug Administration. Anticancer drugs based on the process could be available within a few years. (PATENT APPLICATION 09/126,229).
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Soil, Water and Air Quality

Farmers can boost their soybean yields by tilling clay soils to a depth of 12 to 16 inches in the fall when the soil is dry.

This tillage practice, called subsoiling, could particularly help farmers in the Mid-South region, where many soybean crops don't yield enough to make a decent profit because clay-laden soils block water from reaching plant roots. Subsoiling allows water to infiltrate deeper into the soil where it can be stored for thirsty roots. This additional water-holding capacity contributes to higher yields and environmental bonuses—less runoff, less soil erosion, and less sedimentation in lakes and streams.

Scientists conducted a 5-year subsoiling study with both optimum and extremely dry seasonal weather. They found soybeans planted in this system on Tunica clay (clay over loam) produced, on average, 43 bushels per acre compared to 29 bushels per acre under the conventional system with no irrigation.

Subsoiling also produced yields similar to those obtained with conventional systems with irrigation, at 43 bushels per acre versus 45. Net returns were $129 an acre from nonirrigated deep tillage compared to $48 an acre from nonirrigated conventional production and $83 an acre from irrigated conventional production.

ARS researchers say this practice is compatible with conservation tillage practices, since subsoiling doesn't destroy crop residues on the surface and is not necessarily required every year.
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Good news for farmers of steep, hilly regions of the United States: No-till farming will improve yields of silage corn, according to results from three years of ARS field experiments in Appalachia.

No-till has an advantage over conventional tillage in hilly lands because it reduces soil erosion and requires less energy.

The scientists compared no-till and conventional tillage—using a range of application rates for phosphorus fertilizer—to produce silage corn, which is grown for livestock feed. They found that dry matter yields, root length per plant and root density were higher under no-till.

The increased root growth and density under no-till may account for the higher dry matter yield. Plant uptake of nutrients—except potassium, magnesium and manganese—was higher under no-till.

Regardless of tillage system, increased phosphorus application improved shoot and root growth and uptake of nutrients except zinc, copper and iron.
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Food Safety and Quality

Scientists at ARS have developed a technique to rapidly detect DT104, a potentially deadly strain of *Salmonella* bacteria that resists many antibiotics.

Delays in identifying DT104 almost cost a Vermont dairy farmer her life in 1997—and killed 14 of her cows. In addition, the pathogen has killed people in Great Britain and sickened children in Nebraska.

The ARS researchers have found a key gene sequence, present in this virulent strain of *Salmonella typhimurium*, for quick identification. The sooner physicians know they are dealing with DT104, the sooner they can begin the aggressive treatments needed to kill it.

No test kit exists to use the new technique to identify DT104. But the discovery opens the door to development of test kits through an industry partner.
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Durum wheat could find a new home in the bread baking industry, thanks to new research that opens the door to producing light, nutty-tasting bread from durum.

Until now, that wasn't possible if the bread contained more than 25 percent durum. Durum wheat is used in noodles and pastas, but new white winter and spring wheats may chip away at durum's share of that market.

So scientists wanted to find a way to make breads with higher percentages of durum. Using a modified version of the baking industry's sponge dough procedure, scientists baked one-

pound loaves of traditional pan bread made from flour that was 60 percent durum. These loaves had about the same volume as loaves made from 100-percent hard red spring wheat flour.

Hard wheat flour's high gluten content is key to good loaf volume and dough flexibility and strength. Now the researchers are developing dual-purpose bread and pasta wheats containing certain glutenin protein genes found in other wheats.

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New cornstarches that make smoother sauces and puddings may come from genetically diverse corn native to Argentina.

Scientists with ARS and Argentina's Instituto Nacional de Tecnologia Agropecuraria analyzed 239 Argentine corn strains for composition and hardness. These strains were generally about 2 percent higher in amylose cornstarch than the typical 20 to 25 percent in U.S. hybrids.

Amylose cornstarches, because of their straight arrangement of glucose sugar units, create a smoother texture for sauces and puddings. Some specialty U.S. hybrids have 50 to 70 percent amylose, but the Argentine strains may have genes that could boost amylose quality and quantity in new hybrids. Corn's other major starch, amylopectin, has a branched, treelike glucose structure that creates a rougher texture.

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Shipping vine-ripened honeydew melons and cantaloupes in greater quantities to more distant markets is now possible, thanks to a new handling procedure.

Soaking freshly harvested melons in an amino acid/calcium chelate solution for 20 minutes could prolong market life up to 2 weeks beyond the normal shelf life of 7 to 12 days. The soaking supplied extra calcium that, in ripe melons, steadily migrates from the rind to the seeds. Rinds need calcium to maintain a degree of firmness that protects against spoilage.

As shippers adopt the procedure, today's sweeter and more nutritious varieties may become ever more popular with consumers.

In 1997, U.S. per capita consumption of cantaloupes, or muskmelons, rose to 11.7 pounds, eclipsing the 11.2-pound record of 1946.

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A new edible coating keeps stored pecans from becoming rancid for up to 10 months at room temperature.

Rancidity, which gives pecans a stale off-flavor, occurs when oxygen enters a nut and breaks down, or oxidizes, some of its fat.

The new coatings are made from all-natural cellulose, the most abundant polysaccharide found in nature. Commercially available and inexpensive, cellulose could easily be sprayed on pecan nutmeats by processors.

Of the three types of cellulose coatings tested, carboxymethyl cellulose preserved flavor best. It gave the nuts a high gloss without causing them to look or feel oily. The coating also delayed color change—a potentially important feature since consumers associate dark-colored pecans with rancidity.

Generally recognized as safe by the U.S. Food and Drug Administration, the coating would need to be listed on the label as an ingredient. The pecan industry is interested in further developing the coating, which could promote year-round consumption.

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Animal Production and Protection

A beef cattle herd selected for a high rate of natural twinning can excel in productivity.

But scientists say raising this type of herd will only be practical on farms where breeders can provide their cattle with plenty of nutrient-rich, high-quality forage and grain, as well as extra management and labor including calving assistance.

Those conclusions come from a 7-year study of an intensively managed ARS experimental herd developed to have a twinning rate of about 55 percent—much higher than the normal 1 to 2 percent rate in most popular beef breeds. Researching cattle selected for

natural twinning helps scientists gain basic insights on the physiology of reproduction.

In the study, the combined weights of twin calves at weaning were 58 percent greater than calves from single births. Increased productivity from twinning can mean more income per dollar spent, but scientists ferreted out several constraints they're now studying. These include increased incidences of fetal mortalities or premature births, shorter gestation lengths, birthing problems, retention of placental tissue by mothers of twin cows after giving birth, and reduced or delayed conceptions.

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A disease that destroys horses brain cells is currently fatal, but new findings have increased scientific understanding of the disease--and may someday lead to treatments.

The disease, ELEM or equine leukoencephalomalacia, is caused by corn contaminated with the toxin-producing fungus called *Fusarium moniliforme.*

The fumonisin toxin is insidious. A small amount can make a horse sick. The animal may appear healthy while suffering irreversible damage.

Scientists at ARS and USDA's Animal and Plant Health Inspection Service, in collaboration with Emory University, found that the toxin interrupts the way a horse's liver and kidney make a special kind of fat known as sphingolipid. The toxin also causes an intermediary fat molecule, called sphinganine, to accumulate.

ARS researchers found that another fungus, *Isaria sinclairii,* produces a compound called ISP-I or myriocin. The compound temporarily reduced sphinganine accumulation in mice with no ill effects. If confirmed by other studies, the myriocin discovery might lead to treatments.

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Raising pigs with a natural ability to resist edema disease caused by a specific intestinal *E. coli* bacteria could be possible, based on a new test.

Researchers with ARS and Pig Improvement Co, in Frankfort, KY, developed and patented a DNA-based test to identify pigs that are genetically resistant to the F 18 *E. coli* strain that causes edema. Rapid growth of F 18 *E. coli* in the small intestine of weaned 3- to 14-week-old pigs leads to edema disease, characterized by a excessive buildup of body fluids.

The death rate for pigs with full-blown edema disease is about 65 percent. Breeding healthier, more disease-resistant pigs may lead to reduced use of antibiotics. The test has been validated on more than 500 pigs.

The research was funded, in part, by the Biotechnology Research and Development Consortium in Peoria, IL.

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Fly ash could give dairy farmers a low-cost material for paving feedlot areas where deep mud can sap cattle of energy to produce milk.

Fly ash is a powdery byproduct of burning coal to generate electricity. Normally, it is trucked off to landfills at a high cost to electric utility companies. Some of the ash can be recycled into material for making concrete or spread on crop fields to neutralize acidic soils.

But ARS and collaborating scientists showed it also can be mixed with water and applied to muddy feedlots, offering a low-cost alternative to concrete. Fly ash dries just as hard as concrete but costs roughly $6 per square yard, versus concrete's price tag of $75. Fly ash paving also poses little danger to the environment, leaching only minute traces of certain elements and heavy metals like nickel, the scientists' studies determined.

Besides giving cattle a leg up on mud, fly ash paving also helps contain nutrients in the animals' manure. Preventing cattle from getting mired in mud also reduces their exposure to a range of diseases, including a viral hoof ailment called hairy wort, and a costly udder infection called mastitis.

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If managed properly, grazing-sensitive eastern gamagrass has potential as a forage crop.

The high productivity and moderate forage quality of this native grass have sparked ranchers' interest. The drawback to gamagrass has always been its sensitivity to heavy grazing. It requires careful management, such as rotational stocking (alternating grazing and at least 45-day rest periods.)

In a new 3-year study, ARS researchers placed 500-pound steers on eastern gamagrass pastures in early May at stocking rates of 1.2, 2 and 3 steers per acre for each of the 3 years. Cattle were removed from the pasture once they grazed grass down to 12 to 15 inches height.

Overall steer gain per acre was best for the highest stocking rate with the shortest grazing duration. Heavier grazing earlier in the season means more time for pastures to bounce back and replenish themselves. Also, the forage is used early in the season when the quality is highest.

Gamagrass tolerated grazing over the 3 years, since all pastures remained productive. Interestingly, grazing actually increased plant density in the pasture, rather than thinning it out.

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Aquaculturists who raise sunshine bass can now decide with confidence when to stock their ponds. ARS scientists have established an environmental window of opportunity when tiny creatures called zooplankton become available for the small fry to eat.

The trick: Stock when microscopic rotifers and minute crustaceans become numerous enough to feed the fish but before larger zooplankton grow and devour the fry.

Pond temperature strongly affected buildup of the rotifers. Rainfall drove the growth of the crustacean *Copepod nauplii*, another favorite food for young sunshine bass.

By factoring in other influences like day length, dissolved oxygen levels and the air temperature outlook, the scientists developed graphs and equations that fry culturists can use to help manage their operations. Fast-growing sunshine bass—a cross between the sport fish, striped bass and white bass—quickly reach market size in ponds.

These food fish make up a small but rapidly developing industry.

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Human Nutrition

Ever feel hungry a few hours after a big meal? A new study may explain why: Chances are you ate carbohydrate-containing foods that caused a rapid spike in your blood sugar. This musters extra insulin into the blood. But the high insulin makes blood sugar crash and suppresses the fat fuels as well, leading to that famished feeling that makes you overeat. That's what happened in a study of 12 obese teenage boys by researchers at Children's Hospital in Boston and the USDA research center at Tufts. The study is the first solid evidence that carbohydrate foods with a high glycemic index (GI)—those which are rapidly digested and absorbed—contribute to obesity.

On three separate days that were at least a week apart, researchers fed the boys breakfast and lunch having either a high, medium or low glycemic index. The boys ate almost twice as much after the high-GI meals, compared to the low-GI fare.

The researchers concluded that high-GI meals induce a sequence of hormonal and metabolic changes that promote overeating in obese people.

About one-fifth of U.S. children and one-third of adults are now overweight, despite a drop in fat intake over recent years. Most starchy foods commonly eaten in North America have a high GI. Moreover, many of the low-fat foods that have flooded grocery shelves are also high in calories.

Some starchy foods have GI's up to 50 percent higher than even table sugar. Sources of concentrated sugars, such as sodas and fruit juices, also have a high GI. By contrast, vegetables, legumes and fruits generally have a low GI.

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Foods that score high in an antioxidant assay called ORAC may protect cells and their components from oxidative damage, according to studies of animals and of human blood. ORAC, short for Oxygen Radical Absorbance Capacity, is a test-tube analysis that measures the total antioxidant power of foods and other chemical substances.

Early findings suggest that eating plenty of high-ORAC fruits and vegetables—such as spinach and blueberries—may help slow processes associated with aging in the brain and other parts of the body.

In other research studies, consuming high-ORAC foods has so far been shown to (1) raise the antioxidant power of

human blood 10 to 25 percent; (2) prevent some loss of long-term memory and learning ability in middle-aged rats; (3) maintain the ability of brain cells in middle-aged rats to respond to a chemical stimulus, a function that normally decreases with age; and (4) protect rats' tiny blood vessels—capillaries—against oxygen damage.

The thesis that oxidative damage culminates in many of the maladies of aging is well accepted in the health community. The evidence has spurred skyrocketing sales of antioxidant vitamins. But several large trials have had mixed results.

Combinations of nutrients found in foods may have greater protective effects than each nutrient taken alone, the researchers contend. The 10 highest ORAC fruits, in descending order, are prunes, raisins, blueberries, blackberries, strawberries, raspberries, plums, oranges, red grapes and cherries. The 10 highest ORAC vegetables are garlic, kale, spinach, Brussels sprouts, alfalfa sprouts, broccoli florets, beets, red bell peppers, onions and corn.

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A study of ferrets explains how high-dose beta carotene supplements may have increased lung cancer rates among smokers in two large intervention trials reported in 1994 and 1996.

Excess beta carotene stored in the lungs became oxidized into products that turned the normal control of cell division upside down. These oxidized metabolites decreased a tumor suppressor and increased a tumor promoter in the animals' lungs.

Ferrets metabolize beta carotene very much like humans. So researchers tested them with the human equivalent of 30 milligrams of beta carotene daily—the dose given in the large intervention trials. Daily for 6 months, one group was given the beta carotene supplements and exposed to cigarette smoke—equivalent to a person smoking 1.5 packs a day. Two other groups got either the supplement or smoke exposure, while a control group got neither. The group getting both treatments had the strongest precancerous changes.

The products of genes that promote cell division were three- to fourfold higher in these animals than in the control group. The findings point out the importance of understanding how the body handles nutrients before high doses are recommended.

Beta carotene in amounts obtained from fruits and vegetables is completely safe. Populations that eat more fruits and vegetables rich in beta carotene and other carotenoids have a lower incidence of cancer, particularly lung cancer.

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A profile of U.S. blood homocysteine levels confirms findings of earlier, nonrepresentative studies: This recently recognized risk factor for heart disease increases with age and is higher in males than females.

Homocysteine is produced during the conversion of one amino acid into another. Incomplete conversion causes a buildup of homocysteine in the blood, where it is thought to irritate artery linings, encouraging formation of plaque—fatty deposits that cling to artery walls.

The researchers used sera from the latest National Health and Nutrition Examination Survey to measure homocysteine for 3,766 males and 4,819 females from age 12 up. Homocysteine levels between the two genders were closest in the young and old, diverging around puberty and converging after menopause.

One unexpected finding: Mexican-American females had the lowest homocysteine levels—significantly lower than non-Hispanic African American and white subjects.

Low intake of folate, vitamin B_{12} or vitamin B_6 can be a cause for the homocysteine buildup. Orange juice and green leafy vegetables are good sources of folate, which seems to have the most impact on homocysteine buildup.

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Women who overemphasize being slim at the expense of good nutrition may increase their risk of osteoporosis.

ARS scientists in California looked at the eating behavior of 192 women volunteers, ages 18 to 50. The women all were healthy individuals who did not have anorexia or bulimia.

Using a standard test, the scientists classified them as either "restrained" or "normal" eaters. The 51 percent classified

as restrained eaters had about 12 percent less mineral content in their bones and about 6 percent lower bone-mineral density than the women classified as having normal eating behavior.

The test is known as a Three-Factor Eating Inventory. It's already known that not getting enough calcium-rich foods can lead to low bone-mineral density.

But the ARS investigation is apparently the largest of its kind to demonstrate a significant association between restrained eating and bone mineral content or density. If the sample is representative, the findings suggest that about half of U.S. women could potentially be restrained eaters who may be increasing their risk of osteoporosis.

A thinning and weakening of bone, osteoporosis increases the risk of fractures, particularly of the hip and spine. In the U.S., estimated annual costs of this disease are more than $10 billion for care alone.
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Rett Syndrome, a debilitating disorder that strikes only girls, causes mental retardation and growth failure. There is no cure.

But nutrition research may lead to improvement in the quality of life for those with this disorder. Researchers compared energy balance—calories consumed minus calories used—of healthy girls and girls with Rett Syndrome. Both groups had a positive energy balance, but it was lower than average in the Rett girls.

Researchers conclude that this subtle, long-running energy deficit plays a role in slowing the girls' growth. Some physicians have had success with a surgically implanted device that allows nutrients to be delivered to the child's body while she sleeps.

One girl being studied at these facilities increased her weight from 31 to 48 pounds in a year, allowing her to sit up for the first time.

But researchers would like to know why the nighttime feedings seem to increase body fat more than lean muscle mass. The prevalence of Rett Syndrome ranges from 1 in 10,000 to 1 in 23,000 live female births.
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Dietary variety and the foods' calorie density may be important determinants of body fatness. That's according to a study of 71 healthy men and women aged 20 to 80.

Researchers divided foods the subjects reported eating over 6 months into 10 food groups. In a statistical analysis, they looked for relationships between eating habits, energy intake and fatness.

In general, those eating the widest variety among several calorie-dense food groups had more body fat, regardless of age or sex.

By contrast, those eating the widest variety of energy-sparse vegetables were leaner.

Variety among dairy foods, fruit and caloric beverages—milk, orange juice, regular soft drinks or spirits—was not associated with intake or body fat.

The calorie-dense food groups were sweets, snacks, condiments, entrees and carbohydrates. Examples of sweets: ice cream, doughnuts, cookies, cakes and candy. Snacks: potato and corn chips, popcorn and French fries. Condiments: gravies, peanut butter, butter, margarine and salad dressings. Entrees: meat, poultry, fish, hamburgers, hot dogs, pizza, mixed dishes, soups and chili. Carbohydrates: rice, potatoes, breads, crackers, bagels, rolls and tortillas.

The researchers believe the findings help explain the national rise in obesity, because an enormous variety of calorie-laden foods—particularly snacks and carbohydrates—have flooded supermarket shelves in recent years.
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Getting enough copper during pregnancy may be important for baby's brain development, according to a study of newborn rat pups.

The brain has several enzymes that suffer from a shortage of copper. Some of the enzymes contain copper. Others, like PCK, don't contain it but are less active in its absence.

Researchers focused on PKC, measuring levels in the rat pups' brains after birth.

Throughout pregnancy and afterward, one group of rat mothers got only 1 microgram (mcg) of copper daily—one-sixth the level recommended for pregnant rats. The second

group got 2 mcg, and a control group got all they needed.

PKC increased in all the pups' brains during the 3 weeks after birth. But compared to the control group, the increase was only about half as much in the group whose moms got 1 mcg of copper. Pups from the 2-mcg group also had a smaller increase—25 percent less overall, with one form of PKC lagging by 50 percent in the cerebellum, which controls motor function.

This is significant because poor muscle coordination is a well-known symptom of copper deficiency in baby animals. The findings may have implications for people in the U.S. and other industrialized nations where copper intake is less than desirable.

Between 1.5 and 3 milligrams of copper daily is currently suggested for all adults. Rich sources of copper include oysters, liver and cocoa. Whole grains, nuts and seeds are also good sources.
Grand Forks Human Nutrition Research Center, Grand Forks, ND
W. Thomas Johnson, (701) 795-8411, tjohnson@gfhnrc.ars.usda.gov.

Industrial and Nonfood Products

An ARS processing technique could find a new home for soapstock, a gummy byproduct of edible oilseed refineries that typically ends up in livestock feed.

Scientists developed techniques for converting the soapstock into a thin, biodegradable film that could prove ideal for coating seeds, encapsulating chemicals or other applications. A rich store of triglycerides, phospholipids and other substances in the material makes it biodegradable and soluble in water and oil. The scientists' studies indicate such features control the release rate of fungicides encapsulated in soapstock and applied with water.

The scientists are also exploring ways to refine the soapstock film into a packaging material for peppers, grapes and other fresh produce that perishes easily.

Another possible use for the soapstock: in hair styling gel. Finding new ways of recycling soapstock is a top priority of oilseed processors.

Soapstock stems from an oil extraction and refinery process commonly used on seedmeal of cotton, safflower and sunflowers. Cottonseed mills, for example, generate 60 to 120 million pounds of soapstock annually. Mixing it into feedstuffs is a standard disposal method. But because of the presence of gossypol, a harmful toxin, in soapstock from cottonseed, there's a limit to the amount of soapstock that can be added to feed.

Scientists are now seeking patent protection on their process for refining soapstock and removing its gossypol and other impurities.
Southern Regional Research Center, New Orleans, LA
Sam Kuk/Amy Ballew, (504) 286-4552, mskuk@commserver.srrc.usda.gov

By growing alfalfa, Midwest farmers may soon reap more than hay. From this staple forage crop, researchers produced lactic acid yields as high as 60 percent with a new nonchemical treatment.

Lactic acid is commonly used in foods as a flavoring or preservative, but new markets are being developed for its use in biodegradable plastics. The current U.S. market for lactic acid is about 50,000 tons, but more than half is imported.

The researchers used hot water to pretreat the alfalfa fiber before adding hydrolytic enzymes and a *Lactobacillus* bacteria that ferments five- and six-carbon sugars. The alfalfa fiber, from which lactic acid is made, is left after juice is extracted from freshly cut herbage to make other high-value products, including food- and feed-grade proteins, and nutritionally valuable substances called carotenoids.

The cooperative research with the University of Wisconsin has also produced industrially valuable enzymes from transgenic alfalfa. The products range in value from $1,000 to $2,000 per acre annually.
U.S. Dairy Forage Research Center, Madison, WI
Richard G. Koegel, (608) 264-5149, rgkoegel@facstaff.wisc.edu

Crop Diseases and Pests

Biotechnology may keep head scab disease from infesting barley seeds.

That would alleviate barley growers' economic woes from the disease caused by the fungus *Fusarium graminearum* in the upper Midwest.

ARS researchers have cloned two barley genes associated with production of two antifungal proteins, permatin and hordothionin. These proteins are only found inside the barley seed and may play a role in slowing fusarium's entry into the seed.

Next, the researchers will redesign barley to produce the proteins on the leaflike structures surrounding the seed,

where fusarium infection begins.

In the spring of 1999, they'll determine if the transformed barley expressing these genes has an increased resistance to the disease-causing fungus.

Head scab disease causes millions of dollars in crop losses of barley, wheat, oats, rye and corn.
Cereal Crops Research Unit, Madison, WI
Ron Skadsen, (608) 262-3672, rskadsen@facstaff.wisc.edu

Brazil has partially lifted its 3-year-old prohibition on U.S. wheat imports, thanks in part to an ARS scientist's survey. His nationwide polling of nematologists confirmed that the wheat seed gall nematode no longer occurs in the United States, a result of improved seed-cleaning procedures that disrupt the pest's life cycle.

U.S. wheat had been exported to Brazil for decades, but in 1995 Brazil halted shipments of the commodity, chiefly because of the wheat seed gall nematode. The pest was once widespread throughout the southeastern United States and often caused total crop loss.

Last June, the ARS researcher presented survey results and related information to a Brazilian administrative and scientific delegation. The meeting included representatives of U.S. Wheat Associates (USWA) and USDA's Animal and Plant Health Inspection Service (APHIS) and Foreign Agriculture Service.

An APHIS fungus expert addressed Brazil's concern about the wheat-borne fungi and USWA representatives described how wheat is processed, stored and shipped to eliminate these pests.

Before the ban went into effect, U.S. growers sold wheat valued at more than $50 million a year to Brazil, one of the world's largest wheat importers.
Nematology Laboratory, Beltsville, MD
David J. Chitwood, (301) 504-5660, dchitwood@asrr.arsusda.gov

New information about the anatomy of a microscopic worm, the lesion nematode, will help scientists identify weak links in this worm's reproductive process.

After its cousins—the soybean cyst and root-knot nematodes—the lesion nematode ranks as the world's third worst parasite of crop plants. Species of plant-parasitic nematodes infect nearly every important U.S. crop and horticultural plant, causing huge economic losses.

For its part, the lesion nematode—besides damaging plants—exposes them to other destructive soilborne microorganisms.

But with a powerful instrument known as a transmission electron microscope, ARS scientists for the first time studied and mapped the structure of the male lesion nematode's reproductive system.

This knowledge will help scientists gain the upper hand on this destructive plant pest and could lead to new alternatives to chemical nematicides. Today, only a few chemical controls for lesion nematodes are available, and they often are inadequate, unsuitable or too costly.
Nematology Laboratory, Beltsville, MD
Burt Endo, (301) 504-8046, byendo@juno.com

IPM/Biological Control

A tiny parasitic wasp from Europe is a promising natural control for the tarnished plant bug, a major pest of strawberries in the eastern three-quarters of the United States.

In New England, the bug causes average annual losses of $300 per acre to strawberries. Chemical insecticides are growers' only sure remedy. But as a result, the bug has nearly eliminated organic farmers from growing the crop, since they can't use chemical insecticides.

An ARS scientist imported the *Peristenus digoneutis* wasp about two decades ago. When a female *Peristenus* stings a young plant bug nymph, she lays a tiny egg in it. A few days later, a wasp larva hatches and begins to eat the nymph, killing it in about a week.

The parasite was first released experimentally in northern New Jersey in alfalfa—a widely grown crop that is a plant-bug favorite. The wasp soon reduced the pest's numbers in alfalfa fields by 75 percent. It has gradually spread into six other northeastern states—New York, Rhode Island, Massachusetts, Connecticut, Maine, Vermont and New Hampshire.

The next goal was to determine if the parasite would fly from alfalfa to nearby strawberry fields and attack the bug there. In 1998, ARS and state cooperators in New York and New Hampshire confirmed that it would. They found that the wasp was present in most strawberry fields they checked and it was parasitizing up to 55 percent of the tarnished plant bugs.

Future research will determine if the wasp can kill enough tarnished plant bugs to reduce the bug's strawberry damage to minor levels. That would lower and possibly eliminate the need for insecticides, as well as reduce production costs.
Beneficial Insects Research Laboratory, Newark, DE
William H. Day, (302) 731-7330, ext. 24
tropp@udel.edu

Gypsy moth caterpillars seeking refuge beneath burlap skirts placed on tree trunks could be in for a fatal surprise.

Applying a latex coating of chloryrifos insecticide beneath the skirts can kill more than 60 percent of caterpillars hiding there.

The skirts are a property owner's first-line defense against the leaf-eating insects, a costly menace to millions of acres of forest and shade trees, primarily in the Northeast and Mid-Atlantic areas. The skirts exploit the tendency of caterpillars on the ground to hide during the day and emerge at dusk to feed high in the tree canopy.

Property owners must check under the skirts before dusk and destroy any caterpillars they find. Dropping the pests in a bucket of soapy water or bleach does the trick. But on large properties, this can become tedious.

To save time, and ensure fewer caterpillars escape detection, scientists apply the insecticidal latex coat directly onto the bark beneath the skirts.

In one 31-day field test, they observed that a single 6-hour exposure period killed 64 percent of caterpillars hiding there. On uncoated tree trunks with the skirts, 95 percent survived.

Scientists hope to replicate the results this spring. Eventually, they may try using a biopesticide product containing spores of natural, caterpillar-killing fungi.
Insect Biocontrol Laboratory, Beltsville, MD
Geoffrey White, (301) 504-5689, gwhite@asrr.arsusda.gov

New high-tech capsules offer a better way to feed beneficial insects and to control pests.

ARS scientists are working with researchers at Analytical Research Systems, Inc., Gainesville, FL, to develop low-cost, biodegradable capsules that could be used as food supplements in the field to maintain beneficial insect populations when there's a shortage of prey.

The capsules might also be filled with microbial pest control agents such as protozoa, bacteria and viruses. Food-filled capsules could also be used instead of natural prey to reduce the costs of mass rearing insect predators for biological control use.

ARS tests with fire ants showed that foraging workers readily take the capsules into their nests, open the package and devour the contents. The capsules, 2 to 5 mm in diameter, hold aqueous and/or oily materials—a key advantage over other capsules that are designed to dissolve in water.

A grant from USDA's Small Business Innovation Research Program and a cooperative research and development agreement are supporting this research.
Center for Medical, Agricultural and Veterinary Entomology, Gainesville, FL
Patrick D. Greany/David F. Williams, (352) 374-5763/5982, pgreany@gainesville.usda.ufl.edu/ dfw@nervm.nerdc.ufl.edu

A triple whammy of chemicals, lime and parasitic wasps could bring relief to people and farm animals plagued by nuisance houseflies.

Pesticides alone aren't enough to control houseflies, because the pests have developed resistance to cyromazine. This popular growth regulator, added to chicken feed, passes through the bird and kills fly larvae in the manure.

ARS researchers and scientists from the Institute of Agricultural Microbiology and Zoology in Buenos Aires, Argentina, conducted field tests in commercial poultry houses with cyromazine-resistant houseflies to find the most effective control.

They found the best system for reducing housefly populations included limited use of topically applied cyromazine—at higher concentrations than the feed additive—along with chemical pesticides, cultural control such as lime, and two parasitic wasps, *Spalangia endius* and *Muscidifurax raptor*. These wasps are found worldwide, including the United States, and do not bite or sting people or animals. The wasps were released at a rate of five of each species per hen per week after pesticide applications were stopped.

Combining these control practices reduced flies by 98 percent and resulted in a 3.5 percent cost savings compared to chemical treatments alone. Combined treatments also resulted in a 2 to 3 percent labor savings.
Center for Medical, Agricultural and Veterinary Entomology, Gainesville, FL
Jerome A. Hogsette, (352) 374-5912, jhogsette@gainesville.usda.ufl.edu

Plant Genetic Resources

A quest for wild lesquerella, a mustard family plant with oils that might be used for industrial products, is taking place this spring and summer in Mexico.

ARS scientists and colleagues from Arizona State University and Mexico's Antonio Narro Agricultural University, Coahuila, will hunt for wild relatives of lesquerella along roadsides, hillsides and gullies in 10 Mexican states.

Seeds of the yellow-flowered plant contain compounds called hydroxy fatty acids. They may be alternatives to those now obtained from imported castor oil to make resins, waxes, lubricating greases, cosmetics and other products.

America imports castor oil from India, Brazil, the Netherlands, the United Kingdom and Indonesia. Natural thickeners made from chemicals on the coat of lesquerella seeds might be used in food processing. What's more, lesquerella's protein-rich meal, left over after the oil is removed, may supplement cattle feed.

Scientists anticipate that breeding America's *Lesquerella fendleri* with wild relatives may yield offspring that bear bigger seeds with more oil and more hydroxy fatty acids. This might boost lesquerella's potential as a profitable new crop for growers in the Southwest.

U.S. Water Conservation Laboratory, Phoenix, AZ, David A. Dierig, (602) 379-4356,ext.265 ddierig@uswcl.ars.ag.gov

An international quest to reveal the structure of nearly all genes in a cousin of mustard may be finished by 2000, four years ahead of schedule. Scientists expect the project to yield the first essentially complete catalog of all genes in a typical plant's life cycle, from seed to flower to fruit.

ARS scientists in California teamed with colleagues at Stanford University and the University of Pennsylvania to work on part of this global investigation of *Arabidopsis thaliana.*

So far, the California-Pennsylvania team has detailed the structure of about 1,500 genes, with 6,000 remaining to complete their share of the project.

They post their findings on an Internet databank so researchers worldwide can look for structural similarities to genes from humans, mice or other organisms, including *Drosophila* fruit flies and the nematode *Caenorhabditis elegans.* That shortens the time needed to uncover a gene's function. Once biotechnologists determine the structure and function of a useful gene, such as one for disease resistance, they may move it into other plants.

A. thaliana has become a botanical "lab rat" because it has much less genetic material than crops like tomatoes, corn or wheat. But information about *A. thaliana* genes should apply to these and thousands of other plants.

ARS/University of California at Berkeley Plant Gene Expression Center, Albany, CA, Athanasios Theologis, (510) 559-5911, theo@nature.berkeley.edu

Quarterly Report

of Selected Research Projects

USDA United States Department of Agriculture

ARS Agricultural Research Service

April 1 1999 to June 30, 1999

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Contact the scientists listed for further information on each research project. For general questions about this report, contact Hank Becker, ARS Information, 5601 Sunnyside Avenue, Beltsville, MD 20705, (301) 504-1624, hbecker@asrr.arsusda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact ARS Office of Technology Transfer, 5601 Sunnyside Avenue, Beltsville, MD 20705-5131. Questions about a company's product and/or research should be directed to the company itself.

This publication is available on the World Wide Web at http://www.ars.usda.gov/is/

Into the Marketplace

Cooperative Research and Development Agreements

...With Exelixis Pharmaceuticals, Inc., South San Francisco, CA, to further develop a mobile genetic element called *piggyBac* that can move between chromosomes and genetically change insects.

ARS scientists are testing *piggyBac* in the Indianmeal moth (*Plodia interpunctella*, a major stored-product insect pest) and the fruit fly (*Drosophila melanogaster*). The *piggyBac* transposable element was discovered by a Notre Dame University scientist in 1985. It could help scientists mark insect populations for better monitoring of populations in products.

The technology will also allow researchers to develop new biologically based pesticides by providing a means to mark and isolate genes in pest insects. This should lead to the identification of new, highly effective crop protection agents. In addition, this partnership should provide a foundation for new tools for advancing genetic research on other agriculturally important insect pests.

Center for Medical, Agricultural and Veterinary Entomology, Gainesville, FL
Paul Shirk, (352) 374-5720, pshirk@gainesville.usda.ufl.edu

... With Tréce, Inc., of Salinas, CA, to commercialize an insect-feeding attractant containing sustained- or controlled-release formulas to help wipe out adult agricultural pests before they can reproduce.

The idea is to lure the adult insects into a trap or an area where they'll gorge on a toxicant combined with a feeding stimulant.

In the south, large numbers of adult corn earworm moths feast on corn before they move on to damage cotton or migrate into northern corn fields. These pests—which also attack sorghum, peanuts, lettuce, tomatoes, and peppers—cost farmers about $2 billion a year in losses and control costs.

Once lured to an area or trap, the insects will "pig-out" on the toxic dish so that only a small helping is needed to kill them. The technology is aimed at reducing pesticide spraying and saving beneficial insects that may otherwise be killed with pesticide spraying.

ARS has applied for a patent on the attractant. (PATENT APPLICATION 09/166,655)

Areawide Pest Management Research, College Station, TX
Juan Lopez, (409) 260-9351, j-lopez@tamu.edu

...With Dow AgroSciences, Indianapolis, IN, to develop and test a bait-insecticide combination to control fruit fly pests, including the Mediterranean and Mexican fruit flies.

The insecticide, called spinosad, is a biologically derived product which is toxic to insects that eat it but harmless to humans. The baits attract specific insects. Spinosad poses less risk than most insecticides to mammals, birds, fish, and beneficial insects.

To further reduce risks to nontarget species and to make more effective use of spinosad, the scientists will test formulations that include Solbait, an ARS-developed bait consisting of hydrolyzed, spray-dried protein and inert ingredients. Solbait is now registered for emergency use in the control/eradication of fruit flies in Florida.

Application technologies will be researched on caged insects at field sites in Texas, Washington, Michigan, Massachusetts, Maine, Mexico, Guatemala and Brazid8

Crop Quality and Fruit Insects Research, Weslaco, TX
Robert L. Mangan, (956) 565-2647, mangan@pop.tamu.edu

...With Oklahoma State University, Stillwater, OK, and Site Specific Technology Development Group (SST), Inc., also in Stillwater, to develop a computerized "decision support system" for using integrated pest management (IPM) to control greenbugs in wheat.

The greenbug, an aphid that seriously damages wheat, is one of the most important insect pests of wheat in the Southern Plains region. During severe outbreaks, economic losses to wheat growers in the region exceed $250 million a year. ARS scientists will coordinate field studies on yield loss and greenbug population dynamics. Then they will formulate and validate the necessary computer simulation models.

Computer programmers at OSU and SST will develop the decision support system. ARS scientists will help develop and validate the system. OSU will work with cooperating farmers and crop consultants to evaluate it under field conditions. SST will provide software integration expertise and make the system available to users.

Improved IPM practices for the greenbug would greatly reduce monetary losses caused by the pest.

Plant Science and Water Conservation Laboratory, Stillwater, OK
Norman Elliott, (405) 624-4141, ext. 227, nelliott@pswcrl.ars.usda.gov

Licenses

A half dozen companies now have licenses to sell CD-II, a crested wheatgrass that ARS and Utah State University researchers developed for livestock and wildlife grazing. CD-II also helps prevent soil erosion.

Leafy, vigorous, and tolerant of drought, insects and diseases, CD-II crested wheatgrass is a results of 11 years of plant breeding and testing. A perennial, CD-II is well adapted to the semiarid rangelands of states in the Intermountain region and Northern Great Plains that get 10 to 16 inches of precipitation a year. The grass is suitable for planting at elevations up to 6,000 feet.

It is related to Hycrest, another crested wheatgrass from ARS, but CD-II is leafier and produces more growth in early spring. However, because CD-II becomes dormant and less palatable in midsummer, it needs to be planted in combination with other grasses and shrubs that can provide forage for that time of the year.

Round Butte Seed Growers, Inc., of Culver, OR, and Wheatland Seed, Inc., of Brigham City, UT, sold CD-II seed for the first time in 1998. Big Sky Wholesale Seeds, Inc., of Shelby, MT, plans to begin selling CD-II this year, as do Rainier Seeds, Inc., Port Orchard, WA, and Newfield Seeds Company, Ltd., Nipawin, Saskatchewan, Canada. Grassland West Company, Clarkston, WA, will begin marketing CD-II in 2000.

Forage and Range Research Laboratory, Logan, UT
Kay H. Asay, (435) 797-3069, khasay@cc.usu.edu

...To Medicago inc., Québec City, Québec, Canada, to introduce genes into the pollen of alfalfa plants to "pharm" them for human medicines.

This is the latest sublicense emerging from a series of research agreements with BTG International Inc., Gulph Mills, PA, since 1993.

More potential sublicenses are being evaluated for other crops and uses. An agreement with BTG resulted in ARS patenting the technique, pollen electrotransformation. It uses normal pollination instead of other gene-engineering techniques. This eliminates the time-consuming and costly process of nourishing gene-engineered cells into whole, seed-bearing plants.

In the ARS technique, pollen is given an electric shock in the presence of the new gene that scientists want to transfer. This causes the gene to enter the pollen cells and become part of their genetic library. It offers the promise of a convenient, economical, and commercially valuable procedure for rapidly producing genetically engineered plants.

ARS and BTG scientists worked together to successfully put the technology into practice for tobacco, corn, and alfalfa. Under an agreement with BTG, ARS scientists, working with scientists at American Cyanamid, Princeton, NJ, are evaluating experimental soybeans, sugar beets and other plants to see if they possess traits the scientists earlier attempted to transfer with the pollen technique.

Okanagan Biotechnology, Inc., Summerland, British Columbia, Canada, will use the pollen technique to transfer genes into cherry, peach, nectarine, apricot, and plum trees to inhibit fruit browning.

Sanford Scientific, Inc., another earlier sublicensee, is working to develop ornamental plants for more eye appeal, less need for pesticide, and other desirable traits. (PATENT 5,629,183)

Climate Stress Laboratory, Beltsville, MD
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Soybean and Alfalfa Research Laboratory, Beltsville, MD
Benjamin F. Matthews, (301) 504-5730, bmatthew@asrr.arsusda.gov

...To Intervet, Inc., Millsboro, DE, to produce the first approved, modified live fish vaccine, which may be commercially available in the spring of 2000.

The ARS-developed vaccine protects young channel catfish against *Enteric septicemia* (ESC), a major catfish disease that costs farmers as much as $60 million a year in losses. This new vaccine, a live organism rendered unable to cause disease, will help the catfish industry solve a key problem and will give producers a more cost-effective way to raise healthy fish for consumers.

The vaccine can be used on fish 7 days after hatching and older. Seven days is the youngest age at which catfish have been vaccinated to prevent infection. It can also be given by bath immersion on the trucks that take young fry to ponds, or in tanks at the hatchery.

The vaccine prevents infection caused by the bacterium *Edwardsiella ictaluri*. ESC is also called "hole in the head," since it is characterized by lesions and holes in the fish's cranium, as well as by a bright red color at the base of the gills and belly areas.

Previously, producers had to give antibiotics in feed to control the disease, which wasn't practical because sick fish don't eat. Also, over time, the ESC bacterium begins to develop resistance to the antibiotics.

The vaccine should provide lifelong protection. In field studies, it reduced catfish mortality by 80 percent. *E. septicemia* accounts for 70 percent of disease losses in catfish. ESC has never been associated with human infection. (PATENT APPLICATION 09/053,261)

Fish Diseases and Parasites Research Laboratory, Auburn, AL
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Soil, Water, and Air Quality

Triclopyr, a herbicide approved for use in some ecosystems, might be the best compound for zapping parrotfeather plants, according to first tests against this alien aquatic weed.

Named for its feathery-looking gray-green leaves, parrotfeather can quickly take over lakes, rivers, irrigation canals and farm ponds. Known to scientists as *Myriophyllum aquaticum*, the plant is native to South America.

In the United States, it is now found in California, Oregon and Tennessee. Dense stands of parrotfeather make ideal breeding grounds for mosquitoes. The plants also crowd out desirable native vegetation, clog irrigation systems and make waterways unsuitable or unpleasant for boating, fishing and swimming.

ARS scientists are the first to test triclopyr on parrotfeather. They conducted the tests at a 20-acre lake in the oak woodlands of Beale Air Force Base in northern California, under terms of an experimental use permit issued by the U.S. Environmental Protection Agency.

Triclopyr, added to the lake in prescribed application rates, worked better than any other option tested at the site. The lake has been infested with parrotfeather for about 20 years.

Resource managers at the Air Force base collaborated with ARS on the tests, along with specialists from Dow AgroSciences LLC. The company markets triclopyr as Garlon 3A for use in some terrestrial ecosystems.

Exotic and Invasive Weed Research Unit, Davis, CA
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Because of the element vanadium, plants may experience a phenomenon similar to people who eat junk food in place of a nutritious meal—the hunger goes away, but the nutrients don't arrive.

Experiments by ARS scientists over the past 3 years have found that plants confuse vanadium, a little- known soil micronutrient, with phosphorus.

Vanadium appears to be harmless to crop plants. But many of them—including corn and soybean—can't use it as a nutrient. And when these crops grab vanadium instead of the phosphorus they require, their growth and development can't reach their potential yields.

Standard soil tests don't measure vanadium, but an ARS-developed test does. It also measures the ratio of vanadium to soil phosphorus and other nutrients. This test could be used to recalculate phosphorus recommendations.

The optimum economic amounts of phosphorus would have to be redetermined through research, this time considering the vanadium-phosphorus ratios when correlating phosphorus concentrations with plant growth.

North Central Soil Conservation Research Lab, Morris, MN
Alan E. Olness, (320) 589-3411, ext. 131, aolness@mail.mrsars.usda.gov

One grazing cow for every 16 acres makes for a more diverse and productive ecosystem than fewer or more cows, at least in the Great Plains.

In a study in northern Colorado that began in 1939, ARS researchers have found a rate of one yearling heifer per 16 acres evens out the production of individual plant species, preventing any one from dominating. Ranch profitability was also highest at this moderate grazing level.

The scientists counted 46 species of plants on the moderately grazed land, compared to 43 under heavy grazing and 36 under light grazing. Plant biodiversity is highest when high numbers of plant species are combined with a more even distribution of plant species.

While ungrazed land also had 46 species, its biodiversity was undercut by the dominance of pricklypear cactus. Cattle weight gains drop significantly when land is grazed heavily because there are not only more mouths to feed, but also less forage to go around

.

Rangeland Resources Research Unit, Cheyenne, WY
Richard H. Hart, (307) 772-2433, rhart@lamar.colostate.edu

Aerial mapping technology has helped Texas officials locate and remove thick patches of exotic weeds from the lower Rio Grande.

With the ARS-developed technology, the Texas Natural Resource Conservation Commission and the Texas Parks and Wildlife Department pinpointed hydrilla and water hyacinth weeds.

During a drought in the area last year, these weeds were sucking up scarce water and obstructing irrigation flow. By boat, the scientists verified the color-infrared video imagery data. The operations helped advance other research that's aimed at conducting wider scale surveys of weed infestations. Remote sensing, global positioning system and geographic information system technologies may help scientists make timely assessments of experimental weed control measures.

Hydrilla, native to Asia, and water hyacinth, native to South America, share a notoriety for clogging marinas, snarling fishing lines and interfering with flood control and hydroelectric power generation.

Uncontrolled, the weeds grow so competitively with other aquatic plants that biological diversity could be threatened in many lakes and streams through southern parts of North America.

Integrated Farming and Natural Resources Research, Weslaco, TX
James H. Everitt, (956) 969-4824, j-everitt@tamu.edu

Chicory may be just the plant to grow for mopping up nutrients leached into the soil from turkey litter compost used to fertilize pastures. Chicory may also be a boon to beef and lamb producers.

Turkey litter is the nitrogen- and phosphorous-rich manure cleaned from turkey houses along with wood shavings used as bedding. Sometimes the litter holds more nutrients than plants can use, posing problems for water quality.

ARS scientists are finding that chicory could be a biological sponge that soaks up any excess from the soil. They found that chicory keeps taking up nitrogen and growing taller at nitrogen rates up to 424 pounds an acre of commercial nitrogen fertilizer.

They are now doing similar tests with composted turkey litter. The scientists are working with British United Turkey of America, a turkey breeding firm in southern West Virginia. They are also working with USDA's Natural Resources Conservation Service to test chicory in NRCS' Southern West Virginia Grazinglands Program. Both agencies see chicory's potential to provide enough protein to increase beef and lamb production per acre.

Appalachian Soil and Water Conservation Laboratory, Beaver, WV
David P. Belesky, (304) 256-2858, dbelesky@asrr.arsusda.gov

Preliminary experiments at a west Texas lab in the heart of Dust Bowl country suggest wind erosion makes soil more susceptible to drought. That's just what erosion did in the 1930's during a long drought accompanied by massive dust storms.

In some mini-Dust Bowl experiments, ARS scientists planted crops on land that was left bare and exposed to the wind for the previous 9 years. Yields of these crops were 40 to 65 percent lower. The results are preliminary data from 1997 and 1998—the first 2 years of growing crops on the eroded plots. Average annual yield reductions were 65 percent for forage sorghum, 58 percent for grain sorghum and 40 percent for cotton and kenaf. The comparison is to crops grown on soil that was not allowed to erode, using tillage techniques and crop residue to protect the soil.

During the 9 years of wind exposure, the eroded land lost 590 tons of soil an acre or about 10 inches of topsoil. Possible reasons for the severity of the yield losses include lower fertility and a loss in water-holding capacity for the eroded soil.

The scientists found that wind erosion selectively removed phosphorus, an important crop nutrient. Phosphorus levels were about 35 percent lower on the eroded soil compared with the noneroded area. The soil loss did not affect the texture of the topsoil. But with more wind erosion, it might eventually, as the deep topsoil wears down to a clay layer that would interfere with crop roots and further threaten yields.

Wind Erosion and Water Conservation Research Unit, Lubbock, TX
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Food Safety and Quality

A new peanut flour could help improve the texture and flavor of low-fat peanut butter.

To make the low-fat peanut butter, manufacturers dissolve the fat in the peanuts. But this process imparts a sticky, gritty texture to the blend. Natural peanut oils also tend to pool on the surface of low-fat butters. (Peanut "butter" is designated as such only if it contains 90-plus percent peanuts or peanut-based ingredients. If there's less than that amount, the product is labeled as a "spread.")

To improve the quality of low-fat peanut butters, ARS scientists modified components in the flour of de-fatted peanuts. The modified flour serves a twofold purpose: to dilute the fat in the butter and mimic the lost fat's taste and texture-conferring properties.

In lab experiments, this resulted in a creamier, tastier peanut butter with 25 to 33 percent less fat than standard commercial products.

The scientists are now seeking a commercial partner to help refine the low-fat butters. Use of the technology, they estimate, could help low-fat peanut butters capture a greater share of the $12 million-plus annual peanut butter market.

Southern Regional Research Center, New Orleans, LA
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Animal Production And Protection

HiMag, a new grass that's high in magnesium, may help protect cattle, sheep, goats and deer from grass tetany or hypomagnesemia.

When ruminants—animals with four stomachs—have too little magnesium in their blood, grass tetany can result. Often fatal, the condition causes an estimated $50 to $150 million in U.S. livestock production losses each year.

ARS and University of Missouri researchers developed HiMag, which is also high in calcium as well as magnesium. The new grass, known as a tall fescue, is suitable for rainfed pastures in eastern, southeastern and Pacific Northwestern states and British Columbia. It has been tested in Arkansas, Georgia, Idaho, Missouri, New York, Texas, Utah and Virginia as well as in Canada. Plans call for HiMag seed to be made available to plant breeders this year.

Though the idea of breeding a high-magnesium forage grass to combat grass tetany isn't new, the ARS and university scientists are the first to accomplish this with a tall fescue. On U.S. pastures, tall fescues are the most widely planted grasses.

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Catfish and trout farmers may one day restore some fish to health by treating ponds with potassium permanganate.

Exposing catfish to somewhat larger than therapeutic amounts of the chemical for 12 weeks left no unwanted manganese in the fish's flesh or liver, according to a study ARS scientists conducted for the Food and Drug Administration. That finding could help bolster the chance that FDA will approve potassium permanganate as a fish treatment.

The ARS researchers concluded that the treatment for catfish poses no hazard to human consumers. Studies with trout produced similar findings. But before potassium permanganate can be approved by FDA for any food fish, further research must be done to determine its potential, at certain concentrations, to help or harm fish.

Potassium permanganate, which works more efficiently than some other chemicals in soft water, chemically burns up, or oxidizes, suspended organic matter in water and can rid water of fish parasites such as gill flukes and *Flexibacteria columnaris*.

U.S. fish farmers lose an estimated $50 million a year to diseases and there are few FDA-approved chemicals and drugs to fight the diseases.

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A new oral vaccine may help U.S. cattle producers cut their losses from a disease that costs more than $1 billion annually.

Bovine respiratory disease, commonly called shipping fever, costs more than all other cattle diseases combined. Commercialization of the new vaccine, which is given to cattle with their feed instead of injected into the animals' muscle, may be 3 or 4 years away.

Field trials involved two groups of calves—a high-risk and a low-risk group. Deaths among the high-risk calves fed the oral dose were reduced from 16 percent to only 4 percent.

Pasteurella haemolytica—the main culprit behind shipping fever—killed 16 percent of the unvaccinated animals, but none of the vaccinated animals. The oral dose also protected calves within 4 days, instead of the 10 to 14 days needed by current injectable vaccines. Injectable vaccines often produce lesions in animals, which could be avoided by use of oral or intranasal vaccination.

The research for the ARS-developed vaccine was partly funded by the Biotechnology Research and Development Consortium (BRDC) in Peoria, IL.

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Reducing phosphorus in dairy cattle feed will save money for U.S. dairy producers and help the environment.

Dairy producers have been feeding too much phosphorous to dairy cows, based on the commonly held belief that high levels are linked to improved reproductive performance.

Over the last 20 years, ARS and other research institutions have conducted 13 studies involving nearly 800 dairy cows eating both high- and low-phosphorus diets. These studies show that cows fed high phosphorous levels had no better reproductive performance than animals fed low phosphorus diets.

Excess phosphorus in water runoff from fields can boost algae and aquatic plant growth in streams and lakes.

The new recommendation: Feed dairy cows 20 percent less phosphorus. The savings for dairy producers could add up to nearly $100 million a year.

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Scientists can now produce sexed sperm faster than ever, thanks to improvements ARS researchers have made to their Beltsville Sperm Sexing Technology.

More than a decade ago, ARS researchers developed and patented the technology, which allows livestock producers to predetermine the sex of their

animals by using sorted sperm. The system separates living female-producing X-chromosome sperm from male-producing Y-chromosome sperm based on their DNA content.

In the past year, scientists have improved the rate of sexed sperm production by 15-to 20-fold, enhancing sexed sperm's adaptability to artificial insemination technology for widespread use in livestock reproduction worldwide.

The technology uses a fluorescent dye that sticks to sperm based on how much DNA they contain. X-chromosome sperm contain about 4 percent more DNA and therefore hold more dye.

This extra dye means they give off more light than Y-chromosome sperm when passing through the laser beam of a high-speed sperm sorter. The sperm are collected in separate tubes with 90- to 100-percent accuracy and with much higher efficiency than in the original technology.

ARS scientists are collaborating with several scientists around the world to establish and perfect the technology for commercial development in livestock production.

To date, hundreds of animals have been born using sexed semen. All animals have been healthy and normal. The technology has been licensed by ARS for use in animals; it has also been licensed for use in human medicine.

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Human Nutrition

ARS scientists are part of an international team pinpointing rice, wheat, corn, bean and cassava varieties high in micronutrients the human digestive system can readily use.

Billions of people have diets low in bioavailable micronutrients, including zinc, iodine, essential trace elements, vitamins and—especially—iron. Once scientists identify varieties high in bioavailable micronutrients, plant breeders can produce new varieties that have critical agronomic and commercial traits.

To tackle the iron problem, the international team screened 24 selected genotypes from thousands of common beans from the seed bank at the International Center for Tropical Agriculture, Cali, Columbia.

Iron levels in the beans ranging from 51 to 157 micrograms per gram of dry weight and zinc levels from 30 to 65 mg/g. Rat feeding studies showed the beans' bioavailable iron varied from 53 to 76 percent.

Recent tests of hundreds of rice varieties also uncovered wide diversity in iron and zinc levels that could be exploited. Future rat and cultured human caco-2 cell studies will determine iron and zinc bioavailability in other micronutrient-enriched staple food crops, including corn, wheat and cassava.

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To guard against osteoporosis, people may be wise to eat more fruits and vegetables as well as dairy products.

Recent research found a significant association between intakes of potassium, magnesium and fruits and vegetables—which are good sources of the minerals—and bone mineral density measurements at the hip and wrist in elderly men and women.

Researchers at the ARS/Tufts center in Boston and at Harvard Medical School analyzed data from 907 members of the original Framingham Heart Study—345 men and 562 women. They found correlations across the board—with potassium alone, magnesium alone, potassium and magnesium together, and fruits and vegetables together.

Men and women with high intakes had stronger bones.

The researchers also analyzed data from a smaller group—229 men and 399 women—looking for changes in bone mineral density over time.

In measurements 4 years apart, they found a slowing of bone loss in men—but not women—linked to potassium and magnesium levels, separately and together, as well as to fruits and vegetables.

Fruits and vegetables may help prevent the loss of bone minerals by counteracting the acid environment generated during normal digestion, the researchers conjecture. When the body's environment is acidic, minerals are believed to be drawn out of the bone to neutralize the acid, thereby reducing bone strength.

It is also possible that potassium and magnesium have direct effects on bone cells. Good sources of potassium include bananas, oranges, tomatoes, potatoes, broccoli and melon. Good sources of magnesium include fruits and vegetables, milk, fish and whole grains.

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Chlorine levels recommended for swimming pools and water parks may not be high enough to kill *Cryptosporidium parvum*, a parasite that causes diarrhea, according to ARS experts

This single-celled organism is transmitted in the feces of infected people and animals. Infection occurs by swallowing oocysts.

Cryptosporidium has caused numerous recent outbreaks in recreational water, such as swimming pools and water parks, often visited by diapered children.

In collaboration with the Centers for Disease Control and Prevention (CDC), ARS researchers tested water that had fecal matter added to simulate conditions in a contaminated swimming pool. When the water contained this organic matter, currently recommended levels of chlorine did not kill the parasite. That's because organic material deactivates some of the chlorine.

Swimming pools are likely to contain hair, skin cells, suntan lotion, algae or leaves, and sometimes urine and feces—all of which can decrease the effectiveness of chlorine. Previous tests showing that recommended chlorine levels are adequate had been conducted in clean water.

Based on the ARS findings, the CDC suggests changes in engineering of public pools and water parks, such as improved filtering and more frequent turnover of the water. It also suggests changes in pool policies, such as requiring diapered children to wear rubber pants or "swim diapers." And it recommends educating staff and visitors about simple measures for preventing waterborne disease transmission: staying out of the pool while ill with diarrhea and for several days afterward; trying not to swallow pool water; using safe diaper-changing and hand-washing practices; giving young children frequent bathroom breaks; and encouraging swimmers to shower before entering a pool.

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Is depression in women of childbearing age linked to low iron reserves?
Not according to a recent study that found no relationship between mood ar.d marginal iron status. That's different from severe iron deficiency, which can cause depression.

About 1 in 5 women of childbearing age has low iron stores compared to1 in 60 men. And twice as many women as men are clinically depressed—a gender difference that begins in adolescence.

Depression is more pronounced among married women age 25 to 45 with children. But earlier studies on the subject produced conflicting findings. So a nutritionist and a psychologist checked 384 women, ages 20 to 45, who were not diagnosed as depressed.

They used a standardized psychological profile and mood checklist to test the volunteers. They also analyzed the volunteers' blood samples by the most sensitive tests of iron stores. There were no relationships between mood scores and three signs of iron status—serum ferritin, serum iron and hemoglobin.

Serum ferritin is the first indicator of iron status to drop, while hemoglobin is the last and most resistant indicator to change. Iron deficiency severe enough to cause depression and fatigue would show up in a simple hemoglobin or hematocrit test.

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Crop Productivity

Nuplains, a new hard white winter wheat from ARS and university scientists, may help Nebraska farmers tap growing demand for the grain crop's sweet, light-colored flour.

Such flour is particularly popular in Asia, where it is commonly used for making "wet" noodles, like those in wonton soup. Asia imports about 300 million bushels of white wheat annually from Australia and other countries. But more American wheat-growing states are seeking to enter that market.

Nebraska has traditionally grown hard red winter wheats. In 1998, it produced nearly 85 million tons, exporting about half. Nuplains, scheduled for commercial sale in fall 2000, will be Nebraska's first white wheat variety.

More importantly, it will give farmers the option of growing a crop whose kernels lack tannins, substances that give red wheat flours a reddish, slightly bitter taste. Because of this, white wheat flours are generally chosen for ethnic foods like pita bred, tortillas and wet noodles.

But white flour is also finding favor on the domestic front in whole-wheat breads, which are typically made from red wheats. One hope is that white wheat's sweeter taste will make the high-fiber, nutritious breads more appealing to kids.

ARS and University of Nebraska researchers developed Nuplains by breeding Abilene, a standard red wheat, with an experimental Kansas white strain. Nuplains is recommended for production west of Grand Island, Nebraska, where drier conditions prevail.

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What's a good way to stop hungry diamondback moths from nibbling on a farmer's cabbage, broccoli, kale and other cole crops?

ARS experiments show the moths can't resist the all-you-can-eat collards when planted completely around cabbage field edges, a strategy called trap cropping that could also work to protect other cole crops.

Invading diamondbacks stop and deposit their eggs on the collards rather than on adjacent cabbage plants. Diamondback populations continue to recycle in collards as long as the plants remain green and continue to grow.

The moths, named for the diamond-shaped markings on their wings, are becoming resistant to many chemicals. Spraying pesticides can be costly, ranging from about $10 to $21 an acre for each application, depending on which pesticides are used.

It typically costs growers $80 to $168 per acre or more for insecticide sprays each season to produce a crop. The simple, low-tech, cost-effective method of planting collards also reduces pesticide use.

Cabbage fields surrounded by collards required 75 to 100 percent fewer sprays to control diamondback moths than fields treated conventionally with pesticides.

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Farmers of the future may be able to get daily readings from space about the health of their crops, thanks to ARS studies of data from the Landsat 7 satellite launched this past spring.

The scientists, based in Arizona, want to improve a method for combining data from Landsat 7's sensor with data from four other satellites. That could make imagery available to growers everyday and give them enough time to do something about problems they detect, such as an insect attack.

Landsat 7's on-board sensor will supply two forms of data—heat emitted from and light reflected by plants and soil.

Meanwhile, radar sensors on four other satellites provide additional data.

Landsat 7, launched April 15, 1999, will pass over a given spot only once every 16 days, but the gaps can be filled by radar data collected nearly everyday.

On overcast days, radar can "see" through clouds that thwart Landsat 7. Landsat's eight-band sensor provides more detailed crop and soil information than the one-band radar sensors.

The National Aeronautics and Space Administration is funding part of the ARS work.

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New computer-imaging techniques are giving scientists the closest look yet at the chromosomes of wild and domestic alfalfa.

Alfalfa is the nation's fourth largest crop, generating more than $6.4 billion annually, primarily as hay. But very little is known about its complex genetic makeup.

By describing the length, shape and distribution of this legume's 32 chromosomes, scientists can begin the task of mapping genes for important traits like winter hardiness, stand persistence, and resistance to disease and pests like potato leaf hoppers.

One hope is that Falcata-type alfalfa cultivars can be used by

breeders to "shuttle" or introduce desirable new traits from wild species into more domestic varieties, broadening their genetic base. That assumption is based on scientists' observation that Falcata alfalfa contains relatively few heterochromatin blocks. A kind of DNA blockage on chromosomes, heterochromatin can impede the free exchange of genes during breeding.

Falcata alfalfa is one of nine main germplasm introductions from which today's commercial varieties are derived. One obstacle to early genetic studies was the fact that alfalfa's chromosomes are virtually identical and barely visible under a microscope.

ARS scientists tackled the problem by attaching a computer-imaging system onto a light microscope. This increased the magnification 10,000-fold, and allowed scientists to add pseudo-coloring to show the chromosomes' features better. The advance also expedited the precise measurement and identification of individual chromosomes.

The scientists credit an image analysis firm, Loats Associates of Westminster, MD, with helping develop the technique.

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Industrial (Nonfood) Products

There may be a market for more than 265 million tires discarded yearly.

ARS researchers have found a new way to recycle material from used tires. They extract the pulverized rubber and polyester/nylon mixture and divide it into two separate materials.

The polyester/nylon fiber is called fluff, and the rubber material is called crumb. Rubber and polyester/nylon fibers are then pulverized using either a freezing treatment and a hammer mill, or by grinding up the material. More than 50 percent of the rubber from this process is recovered, and the remainder is sent to landfills.

The recovered rubber is valued at about $500 per ton. A company that places 12 tons per day in a landfill could potentially turn that into an additional $5,700 a day.

This process is based on cotton ginning technology. Products such as new tires, truckbed liners, running tracks, shoes, carpet backing, brake pads and shoes, asphalt, water hoses and floor mats can be made from the recycled rubber. Several companies are considering licensing this technology. (PATENT APPLICATION 09/107,760)

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When the oil embargo of the 1970's hit, America's farm tractors continued to roll regardless of the oil shortage thanks to ARS research that turned vegetable oils into alternative fuels.

The trend will continue in the 21st century, when motorists will see more vehicles—buses, trains, trucks, and government-owned maintenance equipment—running on biodiesel fuels made from soybean oil.

To help speed the development of biodiesel fuels made with vegetable oils, ARS scientists in Peoria, IL, have adapted a sophisticated tool known as near-infrared spectroscopy, or NIR. NIR is an easier and faster way to check the quality of biodiesel fuel than using gas chromatography, or GC, the current standard analytical tool for measuring biodiesel quality. GC requires more technical expertise and at least an hour to perform.

Another drawback: GC requires special chemical reagents and solvents that need special handling and costly disposal. Using NIR, researchers can measure the conversion of vegetable oil to biodiesel fuel in less than a minute. NIR, coupled with a fiber-optic probe, uses light rather than chemicals to perform the analysis.

The new test will help biodiesel fuel producers determine if their products meet the quality standards of the American Society for Testing and Materials.

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A textile treatment that improves thermal adaptability, absorbency and other desired functional properties in fabric may offer another important benefit.

Coating the fabric with polymers called polyethylene glycols (PEG's) can reduce the growth of certain fungi and bacteria by almost 100 percent, ARS and University of Georgia researchers report.

It works by creating an unfavorable environment for the microbes on and around the fibers of cotton, polyester and other fabrics used to make clothing, linens and other textile products.

Researchers observed substantial growth reductions after inoculating PEG-treated swaths of cotton-polyester bed sheets with spores of two bacteria, *Stapholoccus epidermidis* and *Brevibacterium epidermidids*, and two fungi, *Aspergillus fumigatus* and *Microsporum cookel*.

Staph bacteria can cause skin, wound and other infections. *Brevibacterium* causes foot odor. Both of the fungi can trigger allergies and asthma.

Besides creating an unfavorable growth environment, the PEG fabric treatments may also dehydrate the microbes, rupturing their cell membranes.

More research is needed to confirm the finding. But early indications are the treatment could give clothing and textile makers a new way to incorporate antimicrobial properties into apparel or health care products like underpads used by people with incontinence.

Another benefit: scientists believe the PEGs' antimicrobial action is more physical than chemical. So, fabric-infecting germs should be less apt to develop resistance.

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Liquid epoxies made from cane sugar may help open a new industrial outlet for the sweetener in the form of adhesives, primers, base coats and composite materials.

More than 3 million tons of U.S. cane sugar is produced annually but less than 2 percent is used for nonfood purposes. Cane sugar also has to compete with artificial and low-calorie sweeteners.

Unlike these products, however, it offers an abundant, chemically pure source of raw material for creating liquid epoxies that bind glass, metal, wood and other materials. That's the implication of studies by ARS and university scientists who created the sucrose epoxies.

In one experiment, for example, it took more than 1,000 pounds of force to separate two aluminum plates coated with a hardened sucrose epoxy. The material dries under many different temperatures, forming either a clear glass or rubbery material. And, unlike today's petroleum-based epoxies, the sucrose material doesn't contain starter ingredients like Bisphenol-A.

Some research suggests this chemical may disrupt the reproductive systems of mice, and possibly humans. If the sucrose epoxies are to offer a nontoxic alternative, they'll have to challenge the petroleum products in such areas as price, performance and marketability.

ARS scientists hope to explore such prospects under a cooperative agreement with an industrial partner.

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Guayule, a native shrub that yields high-quality, hypoallergenic natural latex, is now easier to genetically engineer.

A technique refined by ARS scientists should simplify the job of giving tomorrow's guayule new genes that could boost its production of latex, or enhance resistance to a root rot that can attack this otherwise disease-resistant plant.

Guayule (pronounced why-YOU-lee) yields a milky latex which is free of allergens that can cause severe reactions such as anaphylactic shock. An estimated 20 million Americans may be allergic to natural latex in gloves, condoms or other products made from the most widely used source, the Brazilian rubber tree.

ARS scientists bathed pieces of guayule leaves in a solution containing a reworked form of a microbe, *Agrobacterium tumefaciens*. The microbe, with the experimental genes inside, can slip genes into guayule cells. The leaf pieces are then nurtured to form plantlets.

The approach is based on a procedure already widely used to genetically engineer other plants, but the ARS team is apparently the first to use it successfully with guayule. Their approach could replace an earlier, cumbersome technique that required piercing plants with a very thin needle to make an entryway for the microbe. Native to Texas, guayule has been grown experimentally there as well as in California, Arizona and New Mexico.

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Crop Diseases and Pests

Tiny black weevils might help stop the spread of a fast-growing water weed, *Salvinia molesta*, that's infesting parts of eastern Texas.

If the one-tenth-inch-long weevils, known as *Cyrtobagous salviniae*, perform as well in the United States as they have in countries such as Australia, South Africa and India, they might reduce the need for chemical controls.

ARS scientists collected about 850 of the weevils in Florida and, with the help of colleagues from the Texas Parks and Wildlife Department, placed the insects at a salvinia-besieged lake and pond near Jasper, TX, and a reservoir at the Texas-Louisiana border. USDA's Animal and Plant Health Inspection Service helped fund the work.

Weevil adults and young feed on the weed's nitrogen-rich buds. The alien weed has been found not only in Texas and Louisiana, but also in ponds in Alabama, Mississippi and South Carolina, a canal in Florida and a lake in Hawaii. It poses a threat to waterways in other warm-weather states, as well. It produces dense mats of small, oval, green to yellow-green leaves.

The mats can double in size in only a few days. They crowd out native plants, ruin conditions for fish and wildlife, and interfere with flood control and irrigation as well as with fishing, swimming, boating and waterskiing.

C. salviniae weevils showed up in Florida several decades ago and are thought to have a key role in keeping another salvinia species, *S. minima*, in check in that state. Scientists will monitor the weevils to determine if they flourish in their new surroundings.

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Tiny parasitic wasps that biologically control crop-damaging caterpillars like bollworms may help locate hidden toxic chemicals, a joint study suggests.

ARS, Iowa State University, and Oak Ridge National Laboratory are participating in a 4-year study, funded by the military's Defense Advanced Research Projects Agency (DARPA). Under its "Controlled Biological Systems" program, scientists are studying whether the wasps can be used to sniff out chemical odors wafting from explosives like land mines, bombs, live rounds or even nerve toxins.

It's part of DARPA's search for fast, nature-based means of monitoring the environment around military or civilian areas for chemical or biological threats, particularly from terrorist activity.

Key to the approach: an ARS lab technique for training *Microplitis*, *Cardiochiles* and *Cotesia* wasps to associate synthetic odors with food (nectar) and egg hosts (caterpillars).

Of particular interest are odors characteristic of cyclohexanol and trinitrotoluene (TNT). Both chemicals are common ingredients in explosives.

Flight tunnel experiments show the wasps will zero in on tubes dispensing the chemicals at a rate of 0.05 to 30 nanograms per minute, about 3-feet downwind. That's equivalent to a drop of water in an Olympic pool.

Scientists will also explore practical, cost-effective methods of using the wasps for detecting harmful chemicals.

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Plant Genetic Resources

Seed for McVey, a new, scab-tolerant spring wheat for the upper Midwest, was released by USDA- ARS and the Minnesota Agricultural Experiment Station through the Minnesota Crop Improvement Association, St. Paul, for seed increase this past spring.

Farmers will be planting the new seed in the spring 2000 planting season. Wheat and barley scab, a.k.a Fusarium head blight, is a fungal disease. It shrivels kernels of wheat and other cereal crops such as barley. It also produces toxins that can make the crop unsuitable for flour, cereals or malt—in the case of barley—and too toxic for sale as animal feed.

A scab epidemic has caused farmers to lose 470 million bushels of wheat from 1991 through 1997, representing losses of $2.6 billion. Although the epidemic affects 12 states, Minnesota and the Dakotas are the hardest hit.

Certified seed growers will grow McVey to build up

enough seed supplies for commercial sale to farmers. The Minnesota Wheat Research and Promotion Council, Red Lake Falls, also funded, through the Minnesota Crop Improvement Association, an additional 50 acres in California to grow larger quantities of seed.

To date, this spring wheat is the most tolerant and highest-yielding of three varieties developed jointly by ARS and the Minnesota Agricultural Experiment Station at St. Paul. But it is considered a "transitional variety," meaning that some aspects of its tolerance to scab can still be improved.

Research toward a more resistant variety has intensified, with McVey being the earliest product of the increased funding. USDA this fiscal year added an additional $1.2 million in research funds on scab resistant wheat at the University of Minnesota and North Dakota State University at Fargo. ARS scientists at St. Paul received an additional $90,000 and ARS scientists at Fargo received an additional $50,000 for similar work.

The increases are part of an overall $3 million annual boost in research to fight the epidemic, building on the $500,000 that USDA has allocated for additional scab research each year since 1997.

McVey is named to recognize Donald V. McVey, a long-time plant pathologist at the ARS Cereal Disease Laboratory at St. Paul.

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Peach growers and breeders have a new at-your-fingertips resource: a handbook that describes in detail some 700 peach and nectarine varieties.

An ARS researcher compiled the 808-page book, *Handbook of Peach and Nectarine Varieties,* USDA-ARS Agricultural Handbook #714, for commercial and hobby growers, domestic and foreign breeders, and other peach researchers and extension workers. It updates the 25-year-old peach variety bulletin published by Savage and Prince.

It's the most comprehensive book of its kind since *Peaches of New York,* published in 1917. The handbook gives detailed leaf, flower and fruit information. Performance comments focus on varieties grown in the Southeast, but the book also describes the most prominent commercial varieties in other U.S. regions. It details all varieties released by U.S. public breeding programs, including those developed by ARS.

An annotated index has brief descriptions of more than 6,000 varieties, including many obsolete and foreign peaches.

While supplies last, scientists and commercial growers can request single copies from the researcher. The publication is also available from the National Technical Information Service, publication number PB98-149602, phone (703) 605-6000.

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Three new peaches fit for royalty—Sureprince, Autumnprince and Springprince—have been released by ARS scientists.

Sureprince is an attractive, firm peach that ripens in mid-June soon after Juneprince, a popular commercial variety. The chillier the better for this peach: It performs well in the colder parts of Alabama, South Carolina, and Georgia.

Sureprince is no lightweight contender, weighing in at about 1/3 pound and about 2 to 2 inches in diameter if the trees are thinned properly.

Sureprince was so named because it is a reliable cropper. The surface is bright red at maturity with gleaming yellow flesh on the inside. The fruit has melt-in-your mouth texture and good flavor.

Yellow-fleshed Springprince and Autumnprince, named for the seasons near when they ripen, are both adapted to the Southeastern climate. Close to 2 inches in circumference, Springprince ripens in late May. It is firm and softens slowly on the tree, enabling it to have good flavor for an early peach. Autumnprince, close to 3 inches around, ripens in late August to early September when most commercial peaches are finished. It hangs on the tree better than many late peaches, which tend to fall before ripening.

All three new varieties have moderate resistance to bacterial spot, with Sureprince being the most resistant.

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Melissa, Summer Royal and Summer Muscat—three delicious new seedless grapes—may begin showing up in supermarkets in the next few years.

A white seedless grape, Melissa, yields large, sweet berries that ripen about the same time as Thompson Seedless, America's number one seedless grape.

Unlike Thompson Seedless, however, Melissa vines don't need to be sprayed with a natural growth regulator to make the plant form big berries. That saves money.

Melissa is the product of embryo rescue, a sophisticated lab procedure for rescuing tiny seeds that probably would not survive in nature.

Summer Royal black seedless grapes are sweet, large, firm and ideal for snacks and salads. This grape fills a production gap at the end of August, when there are usually few American-grown black seedless grapes on the market.

The Summer Muscat seedless raisin grape may prove ideal for making candy-coated raisins. It has a sweet, strong, muscat flavor somewhat like the traditional Muscat of Alexandria grape, but is easier to candy-coat. That's because Summer Muscat is seedless. Muscat of Alexandria has seeds that must be removed mechanically, making the raisins sticky and hard to process.

Too, Summer Muscat can be dried on the vine after the grape-bearing branches, called canes, are severed. Unlike conventional raisin grapes, dried-on-the-vine grapes can be mechanically harvested, saving labor costs.

ARS scientists at Fresno put the new grapes through 5 to 18 years of testing in California's San Joaquin Valley, then offered cuttings to growers and breeders for the first time this year.
The California Table Grape Commission funded some of the research.

Horticultural Crops Research Laboratory, Fresno, CA
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Blackberry lovers can now obtain a list describing all of Iowa's indigenous blackberries and their cousins, the dewberries and raspberries, thanks to an ARS researcher.

The list will also be of interest to field biologists, botanists, naturalists and land managers such as those with the National Park Service.

The scientist examined more than 5,000 specimens of blackberries, dewberries and raspberries (*Rubus*) found in the eastern United States to prepare the first revision of the native and naturalized species of these plants for Iowa. He identified 28 species in Iowa—one with two varieties—along with a naturally occurring hybrid of two raspberry species.

The list includes information on synonyms, species distribution, time of year for flowering and fruiting, habitat, associated plants and taxonomy by past researchers. County distribution maps are presented for most of the species.

Blackberries are rich in compounds that may help to protect cells from oxidative damage and to slow aging-related processes in the brain and elsewhere in the body.

North Central Regional Plant Introduction Station, Ames, IA
Mark P. Widrlechner, (515) 294-3511, isumw@iastate.edu

Sugarbeet growers who now must rely solely on insecticides to control sugarbeet root maggots may soon have a genetic defense against the pest.

ARS and the North Dakota Agricultural Experiment Station scientists have developed sugarbeet breeding lines F1015 and F1016, the first maggot-resistant lines to produce root yields 70 to 75 percent as high as those from commercial hybrids treated with insecticide.

Commercial hybrids grown in Minnesota and eastern North Dakota would have suffered yield losses up to 42 percent higher from the pest in recent years if growers had not turned to insecticides to combat the maggots.

Sugarbeet root maggots are found on two-thirds of U.S. sugarbeet acreage. As adults, they appear similar to small houseflies. As grayish white larvae, they chew sugarbeet roots. Severe damage may kill plants or weaken them, leaving them more susceptible to a variety of root diseases.

While developing maggot-resistant sugarbeets, ARS scientists are also researching biological controls for the insect pest.

Sugarbeet and Potato Research, Fargo, ND
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Pectin, a key ingredient in making jelly, also appears to play a key role in cotton fiber quality.

This discovery could lead to new ways to improve fiber length and strength.

ARS researchers found cotton fibers have a layer of pectin around their cells that is not present in other parts of the plant. The scientists say this pectin layer appears to allow cotton fibers to elongate, which leads to more fiber, the fluffy white part taken directly from the boll.

This discovery was a surprise because most research has focused on how cellulose—the major component of the plant cell wall—affects fiber quality and length, rather than how pectin has.

ARS scientists found that mutations or certain herbicide treatments can alter cotton fiber.

In lab studies, when they altered pectin amounts, they found that either cotton fiber did not grow or its physical characteristics changed—causing short, squatty fibers, for example.

The scientists are trying to identify the enzymes responsible for producing fiber pectin.

Southern Weed Science Research Unit, Stoneville, MS
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Quarterly Report

of Selected Research Projects

USDA United States Department of Agriculture
ARS Agricultural Research Service

July 1, 1999 to September 30, 1999

Contents

Contact the scientists listed for further information on each research project. For general questions about this report, contact Hank Becker, ARS Information, 5601 Sunnyside Avenue, Beltsville, MD 20705, (301) 504-1624, hbecker@asrr.arsusda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact ARS Office of Technology Transfer, 5601 Sunnyside Avenue, Beltsville, MD 20705-5131. Questions about a company's product or research should be directed to the company itself.

This publication is available on the World Wide Web at http://www.ars.usda.gov/is/

Into the Marketplace

Seed for RoadCrest, a new perennial turfgrass for planting along roadsides or highways in the western states, is now on sale.

A low-maintenance crested wheatgrass, RoadCrest is also suitable for planting at summer cabins, in roughs on golf-courses, or at sites disturbed by mining, construction or wildfire.

Three companies are licensed to sell RoadCrest and are now marketing a small, initial seed supply. They are Wheatland Seed, Inc., Brigham City, UT; Bruce Seed Farm, Inc., Townsend, MT; and Round Butte Seed Growers, Inc., Culver, OR.

ARS scientists and colleagues from Utah State University developed this cold- and drought-tolerant plant during a 15-year period. It is a descendant of parent plants grown from seeds collected in Turkey and sent to ARS for testing. Tests in Utah, Colorado, Washington and Wyoming showed RoadCrest should thrive in regions of the Intermountain and Great Plains states that have mild summer temperatures and about 10 to 20 inches of precipitation a year.

RoadCrest greens up earlier in spring than some other crested wheatgrasses tested. Like other cool-season grasses, that is, plants that put on most of their growth in cool weather, RoadCrest becomes dormant and brown in midsummer. But it greens up again in late summer and fall. The plant's comparatively short stature means it may need mowing only two or three times during summer.

Forage and Range Research Unit, Logan, UT
Kay H. Asay, (435) 797-3069, khasay@cc.usu.edu

Licenses

...To Small Potatoes, Inc., Madison, WI, to use ARS-developed genes to lower levels of natural but bitter-tasting chemicals called glycoalkaloids. High levels of glycoalkaloids can cause researchers to exclude from their breeding programs otherwise promising experimental tubers that might offer appealing texture or color or natural resistance to insects or disease. As a result, efforts to expand the biological diversity of the commercial potato crop are constrained.

In preliminary experiments conducted under a cooperative research and development agreement, Small Potatoes scientists and ARS researchers found that the antiglycoalkaloid genes significantly lowered glycoalkaloid production in potatoes in field tests.

An ARS team in Albany, CA, built the new genes, which have also been tested in Idaho and Wisconsin. The genes are a backward, or antisense form of a natural gene. In nature, the unaltered gene cues potato plants to form an enzyme critical to production of a key glycoalkaloid. The antisense genes undermine production of

this critical enzyme, which has the tongue-twisting name of solanidine UDP-glucose glucosyltransferase.

Potatoes are America's favorite vegetable. The 1998 U.S. crop of 21 million tons was worth $2.5 billion to growers. (PATENT NO. 5,959,180)

Western Regional Research Center, Albany, CA
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Cooperative Research and Development Agreements

...With Ajay North America, LLC, Powder Springs, GA, to further improve strategies for controlling diseases in strawberries, blackberries and muscadine grapes.

ARS researchers will evaluate the effectiveness of two new fungicides developed by Ajay to control major fungal diseases of strawberry, blackberry and muscadine grape. Small fruit growers suffer huge losses annually from crops thwarted by diseases such as anthracnose of strawberry, rosette of blackberry and berry rot diseases of muscadine grapes. These diseases limit production of high-quality fruits in these crops.

Anthracnose is the most important fungal disease of strawberries in the U.S. southeastern region. It is caused by a species of the plant fungus *Colletotrichum.*

Rosette, caused by the fungus *Cercosporella rubi,* is first apparent in a field in early spring when new vegetative growth emerges.

Berry rot diseases include bitter rot (*Greeneria uvicola*), ripe rot (*Colletotrichum* sp.) and Macrophoma rot (*Botryosphaeria dothidea).*

Regular fungicide applications during the growing season will reduce both fruit and foliar diseases.

Small Fruits Research Unit, Poplarville, MS
Barbara J. Smith, (601) 795-8751, bjsmith@ag.gov

...With Bernard's Apiaries, Inc., Breaux Bridge, LA, to raise queens of Russian honey bees that are resistant to varroa mites.

Queens will be delivered to customers early in 2000. Beekeepers will use them to produce more queens for populating hives with mite-resistant offspring.

The Russian bees' genetic resistance will provide beekeepers with a tool—in addition to chemical pesticides—to control varroa mites. The mites, eight-legged parasites that are 1/16-inch long, have attacked bees in almost every state. They can destroy a hive of tens of thousands of bees in as little as 6 months.

The Russian bees, from the Primorsky region of Russia's far east, are the same species as the *Apis mellifera* honey bee used in American hives but are more than twice as resistant to mite attack.

ARS researchers in Louisiana were the first to discover the mite-resistance trait in the Russian bees and, in 1997, became the first to bring them to America.

Additional trips to Russia to collect more queens are planned as part of an ongoing breeding program to boost mite resistance and forestall inbreeding.

Besides producing honey, honey bees pollinate dozens of crops, from apples to zucchini, worth $8 to $10 billion a year.

ARS Honey Bee Breeding, Genetics and Physiology Research Unit, Baton Rouge, LA
Thomas E. Rinderer, (225) 767-9280, trinderer@asrr.arsusda.gov

...With Rohm and Haas Company, Philadelphia, PA, to help develop new fungicides, harmless to humans or animals, that specifically target fungi which infect agricultural plant species.

ARS and Rohm and Haas researchers discovered a new class of sphingolipids, lipids unique to a particular group of fungi, called Oomycetes. Oomycete fungi include species such as *Phytophthora infestans,* the fungus that causes potato late blight—the most destructive potato fungal disease—and fungi that cause other plant diseases.

The researchers are hoping to discover compounds, either natural or synthetic, that inhibit the ability of Oomycetes to produce sphingolipids. This could help them develop new classes of safe fungicides. Because of safety concerns, many currently approved fungicides are being taken off the market. So, farmers need new nontoxic, economical alternatives to help control major fungal diseases.

The scientists hope this collaborative research will aid in discovering compounds that meet these criteria.

Eastern Regional Research Center, Wyndmoor, PA
Robert A. Moreau, (215) 233-6428, rmoreau@arserrc.gov

...With PhycoGen, Inc., Portland, ME, to evaluate a natural compound made by a seagrass as a nontoxic control for fungal diseases such as fruit and crown rot of strawberries.

Scientists are exploring the compound, zosteric acid, as an environmentally safe alternative to chemical fungicides. This natural product is made by eelgrass (*Zostera marina* L.), which grows in many saltwater bays and harbors.

Fungal pathogens rely on spores to infect a plant or fruit, but the spores must first attach to a leaf or fruit surface and then germinate to cause infection. Unlike chemical fungicides, zosteric acid doesn't kill fungi; rather, it may act as a shield, preventing spores from attaching. This approach should be environmentally safe and sidestep the risk of fungi's developing chemical resistance.

Most research to develop fungicides is done by industry and focuses on major crops. A zosteric-acid product will benefit small farmers who grow so-called minor crops. Though grown on relatively few acres, such crops are worth some $31 billion annually to U.S. growers. ARS scientists will conduct lab and greenhouse studies with strawberries and blueberries and examine zosteric acid's antifungal properties.

PhycoGen, which manufactures zosteric acid, will cooperate with ARS to develop a product to protect stored seeds from fungi. The company also is exploring zosteric acid as a marine antifouling agent for boat hulls and in other applications.

National Center for Natural Product Development, Oxford, MS
David Wedge, (601) 232-1137, dwedge@olemiss.edu

...With Northwest Tech LLC, Fairview, OK, to provide new and improved ways to develop commercially useful inbred corn lines for the nation's growers.

The partnership could lead to superior corn lines that possess characteristics for tolerating aluminum toxic soils, growing in dense waterlogged soils and increasing insect tolerance, specifically to corn rootworm.

ARS scientists will breed corn chromosomes into the cytoplasm of Eastern gamagrass (*Tripsacum dactyloides*), a distant corn relative that is common to southern states. Selected inbred lines of commercial field corn, sweet corn and popcorn will be used to transfer their maize chromosomes into the *Tripsacum* cytoplasm.

These hybrids will be evaluated throughout the central United States to determine the influence of *Tripsacum* cytoplasm containing corn chromosomes on adaptation, drought tolerance, phenotypic responses and disease and insect tolerance across a wide variety of soil conditions.

This cooperative research will determine the advantages or disadvantages of having corn chromosomes in a gamagrass cytoplasm, compared to having those same chromosomes in normal corn cytoplasm. This could widen the range of adaptability of corn or improve its suitability for a wider range of soils and lead to development of a new crop for agricultural producers.

Rangeland and Pasture Research, Woodward, OK
Phillip L. Sims, (580) 256-7449, psims@ag.gov

...With Wildlife Management Technologies of Noank, CT, to develop a commercial prototype collaring unit for wildlife.

An automatic device that collars white-tailed deer could reduce Lyme disease in the northeast United States and help control cattle fever ticks along the Texas-Mexico border. White-tailed deer are the primary host for blacklegged ticks, which harbor the bacteria that transmit Lyme disease.

Cattle fever ticks transmit bovine babesiosis. Although white-tailed deer are not the primary host for cattle fever ticks, the deer and other large, domestic and exotic animals seriously compromise efforts to re-eradicate new infestations of these ticks along the U.S.-Mexico border.

ARS scientists developed and patented a collaring unit that lures deer to a specially designed feeder filled with corn. To eat, the animal must place its neck near the collaring mechanism. The feeding deer activate the release of a self-adjusting, flexible collar. Collars are impregnated with amitraz, a pesticide approved for livestock that kills ticks on the deers' hair and skin.

If approved for use on deer, amitraz would be safe to use during the hunting season from October through December when most adult blacklegged ticks feed on deer.

Lyme disease is the most prevalent tickborne human disease in the United States. About 90 percent of the cases reported to the Centers for Disease Control and Prevention occur in the Northeast.

U.S. Livestock Insects Research Laboratory, Kerrville, TX
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Patents

Barley plants of the future might be easier to genetically engineer, thanks to work by the University of California at Berkeley and ARS biotechnologists. Their lab experiments have shown that tissue taken from the growing tip of barley plants may be the best target for gene engineering.

Barley biotech experiments typically target tissue from another source–the tiny embryo inside each developing kernel. But meristematic tissue, if cultivated with techniques developed by the scientists, is more likely to produce hardy plantlets.

The researchers used a helium-powered device to propel test genes, coated on metallic particles, into the cultured meristematic tissue. The approach should help speed and simplify the task of giving barleys of the future new genes to boost the grain's nutritional value or bolster the plant's resistance to insect or disease enemies, for example.

Using the process, the scientists raised healthy, fertile barley plants. They have also used the technique successfully with oats, corn and wheat, and the technique is likely to work with other cereals and grasses, as well.

The researchers are now seeking a patent for the procedure. Barley is used primarily for animal feed and for malting and brewing. A small amount is used for flour and in foods. The nation's 1998 barley crop of about 8 million tons, produced primarily in North Dakota, Idaho, Montana, Washington and Minnesota, was worth about $664 million to growers. (PATENT APPLICATION NO. 60/059,873)

ARS Small Grains and Potato Germplasm Research Unit, Aberdeen, ID
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A new attractant of multiple ant species and a new repellent mean double trouble for pest ants, including fire ants that now also infest California and New Mexico.

ARS researchers developed the attractant, which degrades easily and has little environmental impact. It can be combined with water-soluble toxicants to create a bait.

ARS entomologists conducted studies showing the patented bait (PATENT NO. 5,939,061) attracted imported fire ants, Argentine ants, Pharaoh ants, little black ants, carpenter ants, ghost ants, big-headed ants, little fire ants, acrobat ants and crazy ants. Many of these ants are problems indoors and outdoors and cause agricultural, structural or other damage.

The ARS-developed repellent is a much-needed alternative to insecticides. Many regulations limit or ban insecticides, especially in populated areas. This repellent relies on chemical scents repugnant to ants, discouraging them from entering certain areas or forcing them to leave.

Center for Medical, Agricultural and Veterinary Entomology, Gainesville, FL
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Soil, Water and Air Quality

ARS researchers discovered a species of one-celled green algae that helps break down soil-applied herbicides and could lead to improved soil and water quality. The researchers are looking at microbial populations in three Mississippi watershed lakes—Beasley, Deep Hollow and Thighman—as part of the USDA-ARS Mississippi Delta Management Systems Evaluation Area (MSEA) project. They are evaluating farming practices in the 7,320-acre area surrounding the lakes. ARS studies indicate that farm management practices influence lake microbial populations and their impact on water quality.

Deep Hollow watershed, where intensive conservation practices such as winter cover crops and reduced tillage are employed, had the lowest sediment and highest algal populations. These algae, *Selenastrum* and *Ankistrodesmus*, can absorb and break down herbicides such as atrazine and fluometuron, commonly used in corn and cotton production.

ARS scientists also found that a specific group of bacteria, called fluorescent pseudomonads, can degrade metolachlor, propanil and trifluralin—three commonly used herbicides in the MSEA area.

These bacteria and algae can reduce herbicide longevity in Mississippi Delta lakes.

Southern Weed Science Research Unit, Stoneville, MS
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Using stream gauges, computers and other instruments, ARS researchers are monitoring the environmental impact of grass-based systems for managing dairy cows.

Their work is part of the American Farmland Trust's Cove Mountain Farm Project, begun last year on a 300-acre commercial dairy in Pennsylvania. Popularized abroad, the approach calls for grazing cows on carefully managed pastures of grasses and legumes like clover.

In the United States, large dairy herds are generally confined to indoor feed regimens. But on small- to medium-sized dairies, grazing cattle on pasture can cut operating costs associated with growing, harvesting and storing crops like corn as year-round feed. Another benefit is the savings on housing and waste management costs.

Unknown, however, is the extent to which nutrients from the waste of grazing cows contribute to nitrate leaching and phosphorus runoff. Both can diminish water quality. To assess this risk, scientists installed a network of piping beneath 10 acres of Cove Mountain pasture where the farm's herd regularly grazes. Groundwater captured by the piping is sampled and analyzed. This information tells scientists where, when and how grazing may contribute to leaching.

Elsewhere, stream gauges check for phosphorus runoff from pasture. Chambers that collect carbon dioxide, meanwhile, help scientists monitor the health and productivity of pasture plants.

The findings could usher in new ways for farmers to manage pasture, meet their herd's nutritional needs, and save money.

Pasture Systems and Watershed Management Research Laboratory, University Park, PA
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Food Safety and Quality

A new antibody developed and patented by ARS scientists quickly pinpoints a major antibiotic given to dairy cows and meat animals.

ARS researchers further developed a new test, using this antibody, to detect the antibiotic Ceftiofur. Ceftiofur is used to treat mastitis in dairy cows and respiratory diseases in cattle, pigs and poultry.

The federal Food and Drug Administration routinely screens milk and USDA's Food Safety Inspection Service routinely checks meat products to make sure they don't exceed the tolerances for residues from antibiotics approved to treat animals.

Currently, these agencies measure residues by using time-consuming laboratory analytical methods.

The antibody test is quicker and doesn't require as much cleanup time as chemical tests. The antibody has been licensed to a company for incorporation into an immunoassay for measuring Ceftiofur in milk.

Food and Feed Safety Research, College Station, TX
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Triglycerides—fats in margarines, shortenings and cooking oils—can be separated and identified easily and faster than ever, thanks to the application of a new technique for triglyceride analysis.

This is important news for food processors. Faster analysis of how fats perform in food products will help the food industry shave months off product development.

The new technique is called reversed-phase high-performance liquid chromatography (HPLC)/atmospheric pressure chemical ionization mass spectrometry. The technique can identify 35 or more triglycerides within 2 hours.

Now, triglyceride composition can be correlated with physical properties of the food, such as its melting range, mouthfeel and reaction to refrigeration.

National Center for Agricultural Utilization Research, Peoria, IL
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Animal Production and Protection

New lab tests will allow scientists, regulators and livestock producers to quickly identify animals with bluetongue and epizootic hemorrhagic disease (EHD).

ARS scientists have developed the first single genetic test that distinguishes all five types of the bluetongue virus in the United States. They've also developed rapid tests that distinguish bluetongue from EHD.

Bluetongue is so named because it can cause a loss of oxygen, resulting in a blue tinge to the tongue. It affects sheep, goats, deer, elk and antelopes. Cattle can carry the virus but usually don't become ill. Worldwide, there are 24 strains. Countries without it strictly regulate import and export of livestock and related products, costing U.S. producers about $125 million annually.

Previous tests were not always conclusive. The new test also is faster, taking 1 day instead of several. U.S. bluetongue testing is performed at the USDA's National Veterinary Services Laboratory in Ames, IA, and the lab has incorporated this ARS test into its procedures.

Researchers also developed tests that identify the two types of EHD present in the United States and that distinguish them from bluetongue viruses. EHD can cause a bluetongue-like disease in cattle and is often fatal to white-tailed deer. Correctly identifying which virus an animal harbors is important for trade purposes. There is no cure for either bluetongue or EHD.

Arthropod-Borne Animal Diseases Research Laboratory, Laramie, WY
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Cattle prefer alfalfa hay harvested in the afternoon to that cut in the morning, according to a new study by ARS researchers. The experiment is a follow-up to earlier work with tall fescue hays.

The tall fescue study was likely the first to show up to a 50-percent difference in forage preferences based on time of cutting. Knowing more about the characteristics of forage that cue animals' preferences can lead to healthier livestock, better weight gains and bigger profits for ranchers.

In addition, the research helps plant breeders develop new forages that appeal to animals. Animals may prefer p.m.-harvested hays because they have more total nonstructural carbohydrates—easily digestible starches and sugars—than those harvested in the morning.

Another ARS analysis of chemicals in tall fescue hays indicated cattle preferred those with high levels of a natural chemical known as 6-methyl-5-hepten-2-one.

ARS scientists at Kimberly, ID; Albany, CA; Watkinsville, GA; and Raleigh, NC; along with university colleagues in four states, are probing additional chemical and physical characteristics of tall fescue, alfalfa and other forages that might affect animals' menu preferences.

Investigations into the influence of minerals like calcium, magnesium and potassium on animals' forage choices are already under way.

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Plant Science Research Unit, Raleigh, NC
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FANS—short for "fan assessment numeration system"—could help solve a thorny technical problem of measuring the air output of in-place ventilation fans in animal barns.

ARS scientists designed and built FANS to measure the performance of ventilation fans in delivering fresh air and removing heat, moisture and dust. Such measurements had been theoretically possible but not technically feasible.

The FANS system consists of a portable anemometer—an instrument developed to measure windspeed—and a computer and software to record and analyze measurements. Traditional measuring techniques have been cumbersome, inaccurate by 8 to 10 percent, and slow, taking 30 to 45 minutes. But the anemometer measures volumetric flow rates within 1 percent accuracy in less than 4 minutes.

While primarily a research tool, FANS has many applications. It can pinpoint the best location for ventilation fans. For example, fans placed at the end of a long poultry house are more efficient than fans along the side walls at the end.

The scientists have used FANS to study effects of fan shutters, exhaust cones, belt guards and propeller deterioration. An egg company saved more than $200,000 after a FANS analysis. The company had just installed belt guards on 1,100 fans in 115 poultry houses to protect employees from possible hand injuries. FANS showed that ventilation remained adequate with the guards, so the company did not have to buy additional fans.

Future studies will test fan output on light baffles, fan belt condition and dust and static pressure.

Poultry Research Unit, P.O. Box 5367, Mississippi State, MS
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A new technique to measure activity of a protein called leptin may lead to leaner chickens.

Leptin has recently been associated with obesity, but until now it had been found only in humans and other mammals such as pigs, cows and mice. ARS scientists recently discovered that it is also present in chickens. This discovery led scientists to develop a technique to study the hormonal activity of leptin in chickens.

Leptin, which regulates appetite and energy expenditure, can lead to extreme obesity, diabetes and infertility if the gene behind leptin production is defective.

The new technique, using a process called capillary electrophoresis, pinpoints and measures genetic material that's unique to leptin. Scientists hope to use the technique to monitor leptin levels in breeder birds.

Maximizing meat and improving production efficiency are major goals for scientists studying chickens. That's because breeding broiler chickens for growth has resulted in increased fat deposition—and reduced reproductive efficiency—in breeder birds.

Scientists hope to use their technique to find a way to regulate the leptin levels in chickens and reduce the birds' appetite. This would make it easier to manage broiler production and still provide consumers with quality meat. Commercial industries may eventually use the technique to select birds for feeding behavior that does not affect the growth of young birds.

Growth Biology Laboratory, Beltsville, MD
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Human Nutrition

Aging rats had significant improvements in some balance and coordination tests after eating blueberry extract for 8 weeks. And it improved the animals' short-term memory, as did strawberry and spinach extracts.

Because little else has reversed deficits in balance and coordination, the findings hold hope for older people. The 19-month-old animals in the study were the equivalent of 65- to 70-year-old humans. At 19 months, the length of time these rats are able to traverse a narrow rod before losing balance normally drops to only 5 seconds, down from the average 13 seconds for a young rat.

After getting blueberry extract, the old rats stayed on the rod for an average 11 seconds. They ate the human equivalent of at least a half cup of blueberries daily.

Daily doses of strawberry and spinach extracts improved their short-term memory about as well as the blueberry extract, but none of the extracts improved long-term memory.

In a lab test of antioxidant potential known as the ORAC assay, blueberries score highest. Other high scorers include strawberries, spinach, prunes, raisins, kale, blackberries and raspberries. ORAC measures the ability of foods, blood plasma and just about any chemical mix to subdue oxygen free radicals. These oxygen radicals can damage cell membranes, DNA and other delicate machinery and are blamed for many dysfunctions and diseases of aging.

Researchers attribute the reversals largely to improvements in nerve cell signaling in an area of the brain that controls both motor and cognitive function.

USDA Human Nutrition Research Center on Aging at Tufts, Boston, MA
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Farmers on the 20-million-acre Central Great Plains are finding that alternative rotations can be 20 to 40 percent more profitable than the traditional wheat-fallow system.

ARS researchers are testing 20 dryland crop rotation and tillage systems, seeking the best alternatives to wheat-fallow.

In wheat-fallow, growers plant one crop every other year and leave the soil bare for a year to store water. Now, some farmers are growing more—and different—crops that are more water-efficient. Wheat-fallow systems use only 40 percent of the average 14 to 18 inches of annual rainfall, but continuous cropping can soak up nearly 80 percent.

Researchers have found that growers can successfully crop continuously in years with normal or more precipitation by using a cycle of four crops and alternating high- and low-water use crops. For example, compared to wheat-fallow, farmers can double the land's productivity with a rotation of wheat, corn, proso millet and—

as the fourth component—field peas, another wheat crop or fallow.

This approach still provides for the crops' water needs, and the crop diversity encourages soil microbes that make the farming ecosystem more sustainable over the long haul.

The researchers have improved water use so well, they're nearing their goal of a crop every year. They're still working on rotations that succeed in dry years. Options include a forage crop and green fallow, which use less water than wheat, corn, millet and sunflowers.

Central Great Plains Research Station, Akron, CO
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Too little dietary copper—common in industrialized countries—may contribute to aging. This thesis is based on animal studies bolstered by indirect evidence.

ARS researchers are finding evidence that copper deficiency spurs sugar molecules to attach to protein molecules. The process, known as protein glycation, is thought to cause much of the tissue damage in people with diabetes.

This glycation increases in all of us as we age. When blood sugar is high, it's more likely that sugar molecules will attach to proteins, called early glycation. And if sugar levels stay high, the sugars' free ends can attach to other proteins or other sites on the same protein, called advanced glycation. These cross links bend proteins out of shape, rendering them useless.

Researchers found that both the early and advanced stages of protein glycation increased significantly in rats fed a copper-deficient diet. One sensitive indicator of advanced glycation was at least sixfold higher in the copper-deficient rats. It was nearly undetectable in the control rats. Human diets contain more copper than the rat diets. But the average copper content of U.S. diets falls below the suggested daily range of 1.5 to 3.0 mg.

The researchers speculate that years of eating a diet low in the mineral may, by increasing glycation, contribute to age-related decline in tissue function. High-copper foods include whole grains, oysters, liver, nuts (particularly Brazil nuts), seeds, cocoa and chocolate.

Grand Forks Human Nutrition Research Center, Grand Forks, ND
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A premature infant's level of lactase—the enzyme responsible for digesting milk sugar—might help physicians identify which preemies are at risk for feeding intolerance, a common complication and main cause of extended hospitalizations.

In a recent study of 135 premature infants, lactase activity was a strong indicator of intestinal maturity, which affects an infant's ability to handle feedings. Premature infants can't be released from the hospital until they are on full human milk or formula feedings.

As a rule, they are started on intravenous feedings at birth. Generally after 2 weeks, they receive supplemental feedings—human milk or special preemie formula—that are gradually increased.

In the study, half the infants began receiving supplemental feedings at 4 days of age; the remainder, at the traditional 15-day-old mark. At 10 days of age, the early feeding group's lactase activity was double that of the infants who received only intravenous feedings. At 28 days, it was still 60 percent higher, even though both groups by then were getting similar amounts in their supplemental feedings.

The infants who received early feedings of human milk had the highest lactase activity. They also were most likely to achieve full feedings sooner and least likely to have abdominal complications.

Children's Nutrition Research Center at Baylor College of Medicine, Houston, TX
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Premature infants fed breast milk fortified with extra nutrients fare better than those receiving special preterm formulas.

Researchers looked for the best feeding regimens in 108 infants born 11 to 13 weeks prematurely and weighing less than 2.5 pounds.

The preemies were fed either a special preterm formula or fortified breast milk, depending on parental wishes. Within each group, milk feedings were initiated at different times, and the tube-feeding method was varied to determine an optimal feeding regimen.

Of all the strategies tested, fortified human milk influenced premature infant health the most. Infants getting fortified human milk graduated faster from intravenous to milk feedings. They also had fewer of the common complications,

such as blood infections and intestinal inflammations that often require surgery. They needed less medication to control spitting up and were discharged from the hospital an average of 2 weeks sooner than their formula-fed counterparts.

The human milk must be fortified with additional protein and minerals like calcium and phosphorus to ensure proper growth and healthy bones in preemies.

Children's Nutrition Research Center at Baylor College of Medicine, Houston, TX
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Dry beans have now been found to be a highly concentrated source of healthful antioxidants—comparable if not superior to tomatoes and other fruits and vegetables.

In a series of beans with different seed coat colors, ARS scientists have so far identified eight compounds known as flavonoids. They have also developed an assay that shows six of the eight compounds have strong antioxidant activity.

Flavonoids appear to be responsible for much of the protective power of fruits and vegetables, including antiaging and anticancer properties. The flavonoids with strong antioxidant activity were found in the seed coating that makes up about 10 percent of the bean. The flavonoids are linked to genes responsible for seed coat color—a useful cue for breeders seeking to improve color as well as antioxidant content.

Scientists are now examining flavonoids from the seed coats of light red kidney beans and red Mexican beans. They also plan to test major market classes such as dark red kidney, navy, black turtle and cranberry beans.

The Michigan Bean Commission has provided funding support for the studies.

Sugarbeet and Bean Research, East Lansing, MI
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Tomatoes with much more lycopene than those now found in stores may be on the horizon if ARS research is successful.

Epidemiological research has suggested that lycopene, which gives tomatoes their bright red color, may help reduce the risk of some cancers.

While working with tomato tissue cultures, an ARS researcher serendipitously uncovered clues about ripening and lycopene formation. As expected, the culture developed into a tomato fruit. Surprisingly, the fruit's green outer leaves, known as the calyx, also ripened into fruitlike tissue.

In this particular tomato, called VFNT Cherry, scientists found that low growing temperatures triggered ripening in nonfruit tissue. Because the fruit was very dark red, they tested the lycopene content and found it to be 10 times the amount in most commercial tomatoes. The scientists are looking for the genes that are activated to increase lycopene production. When they identify the genes, they hope to activate the genes in commercial varieties.

Process Chemistry and Engineering Research Unit, Albany, CA
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Crop Productivity

Even when outnumbered 10 to one, hardworking sunflower leafcutting bees sometimes do a better job of pollinating sunflowers than domesticated honey bees.

There is renewed interest in alternative pollinators because many commercial honey bee hives have been hard hit by varroa and tracheal mites.

The sunflower leafcutting bee is *Megachile pugnata*. ARS researchers conducted the experiments in outdoor enclosures. Pioneer Hi-Bred International, Inc., at Woodland, CA, provided the four 100- by 20-foot screened enclosures. Each held about 600 sunflower plants.

For about 2-1/2 weeks, about 100 sunflower bees in each of 2 cages performed pollination chores. A few thousand domestic honey bees—about 10 times more than the sunflower leafcutting bees—performed the same task in 2 other cages. For one type of sunflower, seed size and total seed weight per flower head were about the same, regardless of which bees did the pollinating.

For the second kind of sunflower, pollination by the sunflower leafcutting bee produced about a 30-percent increase in seed size and total seed weight per flower. Results of a follow-up test should be ready later this year or in early 2000.

Bee Biology and Systematics Laboratory, Logan, UT
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Scientists have discovered a new clue to a mostly mysterious process: How do molecules called phytochromes switch on genes to command a plant to respond to sunlight?

Plants use phytochromes to sense sunlight. Phytochrome-sensitive genes may trigger many responses such as flowering or making sugar for energy from sunlight, air and water.

The scientists, based at the ARS/University of California Plant Gene Expression Center, determined that a kind of phytochrome known as phytochrome B, when activated by sunlight, will bind to a protein called PIF3—a previously unknown step.

Phytochrome B doesn't bind if it is kept in the dark, according to the researchers' lab tests. The phytochrome investigations may eventually lead to new ways to change when and how plants respond to sunlight.

This could speed development of genetically engineered plants that, for example, germinate or flower at times controlled by growers. New clues about how phytochrome B interacts with PIF3 to control genes should serve as a helpful new model of how other signaling pathways might work, such as those that control genes for resistance to drought or insects.

ARS/University of California at Berkeley Plant Gene Expression Center, Albany, CA
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Industrial (Nonfood) Products

New lab techniques should help speed development of guayule, a desert shrub, as a source of high-quality hypoallergenic latex.

The techniques are for extracting natural latex from guayule samples and measuring the amounts yielded.

Soon, gloves and other medical, industrial and home products made from natural latex of guayule, *Parthenium argentatum*, may provide a safe alternative for the estimated 20 million Americans allergic to latex from the most common source—rubber from the Brazilian rubber tree *Hevea brasiliensis*.

Before now there were no reliable, standardized lab procedures for quickly and easily extracting and measuring the latex yield from guayule branches. The procedures that ARS scientists in Arizona and California developed are patterned after those likely to be used in large-scale commercial production.

The techniques obtain at least 90 percent of the latex from samples ground twice at 1 minute per grind, and at least 99 percent from four grinds. Breeders can use the techniques to screen for the highest-yielding guayule plants. And tomorrow's guayule growers can use them to determine the best methods for growing and storing the shrubs so they'll yield the largest amounts of high-quality latex.

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Western Regional Research Center, Albany, CA
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An artificial diet for rearing Colorado potato beetles should expedite laboratory research to develop new chemical or biological controls against the crop pest.

The beetle's grublike larvae eat the leaves and stems of potato, tomato and eggplant crops, costing an estimated $150 million annually in losses and chemical controls.

The artificial diet, designed by ARS researchers, comes at a time of growing concern that the beetle may soon resist standard insecticides like Admire.

To find a suitable replacement or test a biological alternative like parasitic wasps, scientists need large numbers of the beetles. This means rearing them in the lab on a steady supply of potato plants.

But growing the plants is costly and time-consuming—hence the need for an artificial diet.

Originally, the beetle diet included potato leaf powder, as well as oats and other ingredients. However, the scientists have since replaced most of the leaf powder with lettuce. Not only is lettuce cheaper, it is easier to obtain since it is widely available at grocery stores.

In tests, about 90 percent of the beetles ate the diet. About 6 generations have been reared on it so far. Scientists are now comparing each generation's

average weight, growth, egg production and other characteristics.

Once perfected, the artificial diet should allow for relatively inexpensive, year-round research on the beetle.

Insect Biocontrol Laboratory, Beltsville, MD
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A new lure may help improve detection and control of the Malaysian fruit fly, a house-fly-sized pest of crops, including peppers, tomatoes, eggplant, cucumbers and gourds.

ARS scientists in Hilo, HI, and Albany, CA, developed the lure in tests with approximately 1 million lab-reared Malaysian fruit flies, known as *Bactrocera latifrons*.

The researchers designed the lure for use in standard insect traps. Pest control workers in states such as California monitor traps year-round to detect outbreaks of other insects—such as the infamous Mediterranean fruit fly—before they build up.

The Malaysian fruit fly, a medfly relative, is now established on all major islands in Hawaii. If undetected in contraband produce, it could hitchhike to the continental United States and pose a considerable threat to agriculture.

The lure combines a colorless chemical called alpha-ionol and cade oil, a dark brown liquid from prickly juniper, *Juniperus oxycedrus*. Easy to make, the lure doesn't require solvents or additives.

Earlier, ARS scientists in Hawaii and Maryland patented alpha-ionol as a Malaysian fruit fly lure. Later experiments in Hawaii showed adding cade oil to alpha-ionol makes the lure more effective.

The researchers are seeking a patent for the invention. (PATENT APPLICATION NO. 09/120,521)

U.S. Pacific Basin Agricultural Research Center, Hilo, HI
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Hawaiian-grown bananas, shipped to mainland and overseas markets under guidelines that ARS helped develop, should not harbor oriental or Mediterranean fruit flies.

ARS scientists used thousands of freshly harvested bananas from more than a dozen plantations throughout the Hawaiian islands to demonstrate conditions for safely shipping the island-grown fruit without chemical or other treatments to thwart the pesky fruit flies.

That's a boon for growers and consumers alike, because disinfestation treatments may add to costs and hasten spoilage.

Fresh fruit leaving Hawaii for the U.S. mainland or other markets must be free of any hitchhiking medflies or oriental fruit flies. The pests are a constant threat to mainland agriculture; they can attack more than 200 fruits and vegetables.

At least four kinds of commercial bananas won't carry these insects, the scientists determined, if the fruit is shipped full-size, green skinned, and without cuts or punctures. As a result, USDA's Animal and Plant Health Inspection Service late last year approved new, workable regulations for shipping the bananas without disinfestation treatments.

The lab and outdoor experiments were conducted by ARS scientists and colleagues from the University of Hawaii Cooperative State Research, Education and Extension Service and the Hawaii Banana Industry Association. Hawaii growers produced about 21 million pounds of bananas, worth about $7 million, in 1998. Bananas are a good source of potassium, fiber and vitamin C.

U.S. Pacific Basin Agricultural Research Center, Hilo, HI
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IPM/Biological Control

Ground plant fiber, water and other ingredients could prove a recipe for disaster for pesky Formosan subterranean termites.

ARS scientists created the recipe—a new bait formula—to trick foraging termites into spreading slow-acting poisons to their nestmates and queen.

The Formosan termite is among the most destructive of urban pests, costing residents in Hawaii, California, and 9 southern states about $1 billion annually in repairs and controls.

Standard bait systems employ wooden stakes, cardboard or tissue paper to encourage the insects to contact and spread the toxins. But the scientists' new bait contains powerful new termite feeding stimulants, along with ground-up plant fiber and substances that

ensure an environment the termites prefer. The feeding stimulants are made from nutrients and other substances in decaying wood where termites forage for food.

Lab studies show that insects find the new bait, or "matrix," more appealing than wood alone. This improves the effectiveness of slow-acting toxins in poisoning the termite colony. In lab studies, the new matrix often stimulated termite feeding within 2 weeks and required up to 95 percent less toxic material to kill the pests than did standard bait systems. ARS has applied for patent protection on the new bait.

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Chinese leaf beetles were released this past summer in experimental field cages in six states as the first step in a biological control program for the invasive weed saltcedar.

Saltcedar trees, which can grow up to 30 feet tall, infest more than 1 million acres along rivers and streams throughout the West. The leaf beetles have been tested extensively in China and in U.S. quarantine facilities and eat only Old World species of saltcedar. With the help of many cooperative agencies and university researchers, beetle eggs or larvae were put on caged saltcedar plants at sites in California, Colorado, Nevada, Texas, Utah and Wyoming.

Saltcedar was brought into the United States in 1837 to protect streambanks from erosion. But without natural enemies, it has crowded out willows, cottonwoods and other plants crucial to wildlife. Saltcedar trees also degrade wildlife habitat by increasing soil salinity, changing streamflows and increasing wildfire frequency.

USDA's Animal and Plant Health Inspection Service authorized the permits, with concurrence from the U.S. Fish and Wildlife Service, for ARS to release the beetles into cages at selected sites across the western United States.

This is the first time biocontrol scientists have targeted a weed that can be important to an endangered animal—the southwestern willow flycatcher. These birds nest in saltcedar in some locations where the trees had replaced their native willow nesting sites.

For this reason, ARS will conduct 1 year of field experiments during which the beetles will remain in cages. No beetles will be released near nesting flycatchers without FWS approval. If the beetles are approved for release outside their 10-foot-square cages, they should spread several hundred feet per year to nearby saltcedar plants.

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Exotic and Invasive Weeds Research Unit, Albany, CA
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A soil-dwelling nematode may help to biologically control house and stable flies that pester cattle and people.

Stomoxys calcitrans, the stable fly, is among the top insect pests of dairy and beef cattle. The fly sports a bayonet-like mouth part for drawing blood from cattle. Such attacks can stress cattle, leading to poor weight gain, decreased milk and meat production and crowding behaviors that can overheat the animals.

S. calcitrans can also transmit 39 different diseases or parasites. Chemical insecticides are used against both adult flies and maggots, which often develop in manure around cattle feedlots and calf pens.

But chemical fly control is costly, and many insecticidal compounds break down after a few days, exposing cattle to further attack by flies from other sources.

As an alternative, ARS and university scientists are exploring manure treatments using the nematode species *Steinernema feltiae*. It's their top pick from 20 species provided by BioLogic Co., a Pennsylvania firm.

In lab experiments, *S. feltiae* killed up to 99 percent of fly maggots within 48 hours of infection. Feedlot trials begun this spring are helping scientists evaluate BioLogic formulations for protecting the nematode from sunlight and dehydration once applied to manure.

They're also trying to pinpoint where and when to apply the nematode, such as beneath fencing or in early May, start of the fly breeding season.

Midwest Livestock Insects Research Laboratory, Lincoln, NE
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Look-alike water weeds called watermilfoils can now be more easily distinguished at the genetic level, helping weed specialists plan counterattacks.

ARS scientists in California and colleagues at the Washington State Department of Ecology conducted the research using samples of the weeds' genetic material, or DNA. In U.S. waterways, the most pervasive milfoil is the exotic Eurasian watermilfoil. It infests lakes and streams and can block delivery of water to cities and farms. It can also make waterways inhospitable to native plants and animals and fishers, boaters and water-skiers.

Eurasian watermilfoil, or *Myriophyllum spicatum*, is found throughout the United States. The researchers took a close look at samples of this and other watermilfoil species from California and Washington. In scrutinizing the weeds' DNA, they found differences between the Eurasian species and four similar-looking but less troublesome relatives.

The research team is among the first to use a technique known as RAPD, or Random Amplified Polymorphic DNA, to differentiate among milfoil species.

They also used RAPD to detect genetic differences between Eurasian watermilfoil plants from various locales. The differences within this species could prove important if future control programs rely on the weed's natural insect enemies.

The milfoil weevil, *Euhrychiopsis lecontei*, is a biocontrol candidate for Eurasian watermilfoil. Biocontrol insects often are collected at one site and relocated hundreds, even thousands of miles away. But scientists think these little brownish black insects should be put to work where the target Eurasian watermilfoils are the closest possible genetic match to watermilfoils at the insects' collection site.

Exotic and Invasive Weeds Research Unit, Davis, CA
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ARS researchers and cooperators distributed more than 19 million flea beetles to combat leafy spurge, a noxious weed, during 5 field days as part of Spurgefest '99.

The field days were part of The Ecological Areawide Management (TEAM) of Leafy Spurge. TEAM Leafy Spurge is a 5-year ARS research and demonstration program that focuses on the weed's infestations in the Little Missouri River drainage in Wyoming, Montana and the Dakotas.

The costly, noxious weed infests at least 5 million acres in 29 states and Canadian provinces. Infestations double every 5 to 10 years

Cattle won't eat leafy spurge, and productive rangeland can be rendered useless when it takes over.

Ranchers, landowners and land managers took insects from the field days to release on their land as part of an integrated management plan for the weed. During the last decade, ARS scientists imported several species of tiny *Aphthona* flea beetles from the weed's Eurasian homeland.

In 1988, 80 *Aphthona* beetles were released at one site in North Dakota. Today, millions of beetles descended from those 80 are helping rein in the weed.

The insects don't eat other rangeland or crop plants.

ARS Northern Plains Agricultural Research Laboratory, Sidney, MT
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Microorganisms that live in the guts of insects and in the soil may be keys to improving the success of biological control against weeds.

Many scientists around the world study and import natural insect enemies to combat invader weeds such as leafy spurge. But consistent success has been elusive. Microbes may be part of the reason.

ARS scientists discovered that several insects used as biological control agents for leafy spurge and spotted knapweed harbor bacteria known as *Wolbachia*. The bacteria affect sperm in the insects, causing offspring to be up to 90 percent female. This skewed gender ratio can reduce the insects' ability to reproduce. Other microbes are valuable insect allies.

Flea beetles imported to control leafy spurge have been most successful where native soilborne bacteria and fungi also feed on the weed. That's because microbes invade the roots via wounds made by the insects. Both findings suggest useful tactics for mass laboratory rearing of weed-attacking insects.

Scientists are working on lab diets for the insects. In the future, they may try including in these diets a compound to rid insects of undesirable bacteria. Or, they might add beneficial weed-controlling microbes to a diet, so insects would transport them directly to weeds.

Northern Plains Agricultural Research Center, Sidney, MT
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A 5-year study with some 190,000 domesticated honey bees provides new evidence that beekeepers can produce and maintain bee colonies resistant to varroa mites.

The mites are eight-legged, blood-sucking parasites—among the worst enemies of the common honey bee, *Apis mellifera*, worldwide.
ARS scientists, working with a commercial beekeeper in Arizona, populated research apiaries with surviving bees from hives not treated with mite-controlling chemicals called miticides.

The researchers kept these new hives free of miticides. During the test, the hives averaged only 7 mites per 100 bees. In some years, some hives were free of mites.

Other researchers in Mexico, Brazil, Germany and Russia have also found hives of *Apis mellifera* bees naturally resistant to the mites.

The Arizona test provides additional proof that beekeepers and breeders can keep hives free of mites if they use selective breeding to keep their apiaries populated with mite-tolerant stock.

Some beekeepers and breeders are already doing this.

Carl Hayden Bee Research Center, Tucson, AZ
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Plant Genetic Resources

Two new sites for conserving and managing plants important to U.S. agriculture are open in Palmer, AK, and Parlier, CA.

They join 26 other repositories in the National Plant Germplasm System. The NPGS holds more than 434,000 specimens of seeds and other genetic materials of crops and their wild relatives.

Researchers use the germplasm to identify useful traits, like disease resistance, for breeding into commercial varieties.
The National Arctic Germplasm Site in Palmer will house native Arctic plants useful in environmental restoration, some with potential medicinal value, and some grains, legumes and vegetables adapted to high latitudes. Examples are northern-adapted grasses like tussock grass, northern berries like bear berries and nagoon berries and plants with importance to native cultures such as Boreal yarrow.

The Arid-Land Plant Germplasm Regeneration and Genetic Resource Unit in Parlier has two NPGS roles. The site serves as an alternate location for other genebanks to grow out crops that benefit from a long frost-free season.

It also will house plants that grow in dry regions. Among them are jojoba, used in shampoos; guayule, a desert shrub being developed for its hypoallergenic latex; and lesquerella and meadowfoam, potential new oil crops.

National Arctic Germplasm Site, Palmer, AK
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Arid-Land Plant Germplasm Regeneration and Genetic Resource Unit, Parlier, CA
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An Oregon-based group of organic seed growers is joining forces with ARS researchers to preserve a rich diversity of traditional crop plants.

ARS' National Plant Germplasm System maintains a network of 26 repositories nationwide that preserve and regenerate germplasm—seed and other reproductive tissues—of crops and their wild relatives. The system houses more than 400,000 accessions comprising more than 10,000 species. An accession is a genetically distinct group of plants such as a crop variety or wild subspecies.

The Farmer Cooperative Genome Project based in Junction City, OR, seeks to educate growers about the system and contribute to it. To store germplasm long term, plants must be grown out periodically.

FCGP members hope to grow out varieties that may not get much attention from scientists but would be valuable for gardeners and growers. The NPGS would benefit because the growers would collect information on the accessions that may not be available elsewhere; they would return some germplasm to the repositories.

The farmers, in turn, will become familiar with a greater diversity of plants than they might otherwise have access to; they hope to develop a niche market for their seeds.

Since the project started in 1998, more than 300 farmers, seed producers, home gardeners and scientists have joined FCGP. The group has requested about 800 accessions covering more than 50 species from the NPGS.

Western Regional Plant Introduction Station, Pullman, WA
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Across the United States, experimental plots have been sporting the cream of the wild strawberry crop.

Some of the wild plants are showing traits growers will want, such as early flowering and disease resistance.

In the project, six ARS and university scientists have set about creating tomorrow's berry from the original parents of today's commercial plants. Their mission: broaden the strawberry's genetic base and build a bigger, better one in the process.

Two ARS geneticists are among the six evaluating 20 to 40 of the finalists from North and South America during the 2-year project. The project leader is James F. Hancock at Michigan State University in East Lansing.

Horticulturists had already done about 10 serious evaluations of wild strawberry species. The scientific team selected the best and most representative to screen for 18 characteristics that growers and consumers prize most. Early results are promising.

Last April in Beltsville, MD, most of the wild species collection was in flower while the cultivars were just waking up. And the previous fall, one species from Alabama and another from Mississippi were disease-free while all the cultivars were covered with leaf spot, scorch and powdery mildew.

Some of the elite species under evaluation come from ARS' National Clonal Germplasm Repository at Corvallis, OR. Others were recently collected in native habitats—from Chile to the Rockies to Ontario, Canada.

Fruit Laboratory, Beltsville, MD
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Fowler, a new soybean variety resistant to several races of soybean cyst nematodes, has been released by ARS and university scientists.

Soybean cyst nematodes are tiny wormlike pests that attack soybean plants, costing farmers approximately $350 million annually in reduced yields. The main way to control this pest has been using resistant soybean varieties, which the nematodes find unappealing to eat.

Unfortunately, the nematode has superior genetic ability to overcome and adapt to the plant's defenses. Usually within a few years of continuous planting, the nematode adapts to resistant varieties. Therefore, new varieties are important for keeping this pest off soybean plants.

Fowler is resistant to soybean cyst nematode races 2,3,5 and 14 and has high yield potential. ARS researchers developed Fowler from a cross between Holladay and Hartwig, two popular commercial varieties. Seeds are available to certified seed producers and researchers from the Crop Genetics and Production Research Unit.

Crop Genetics and Production Research Unit, Jackson, TN
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Lewis is the first new red raspberry variety released since 1939 by ARS berry breeders for the summer fresh-fruit market.

Lewis plants bear large, glossy, firm fruit in June and July. The berries are larger than those of Meeker and Willamette, standard red raspberries grown in the Pacific Northwest for the processed berry market.

ARS researchers jointly developed Lewis in cooperation with the Horticulture and Food Research Institute of New Zealand.

The new berry's name honors historic figures in both countries. The expedition led by Meriwether Lewis and William Clark spent the winter of 1805-06 in Oregon after reaching the Pacific during their historic overland trek. New Zealand surveyor Henry Lewis discovered a route through that country's Southern Alps in the 1850s.

Lewis red raspberry should grow well in the Pacific Northwest, California and other raspberry-growing areas where winter temperatures don't fall much below zero degrees Fahrenheit.

Raspberries are low in fat and a good source of dietary fiber. Research at the Hollings Cancer Center in Charleston, SC, has indicated that red raspberries may be potent cancer fighters due to their high ellagic acid content.

Horticultural Crops Research Laboratory, Corvallis, OR
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The greenbug, among the worst cereal aphids, may have met its match with a wheat germplasm called GRS (Greenbug Resistant Selection) 1201.

ARS scientists evaluated resistance to three greenbug biotypes in this wheat, Largo (one of the oldest greenbug-resistant germplasms) and the cultivar TAM W-101, known to be highly susceptible.

The greenbug, *Schizaphis graminum* Rondani, is a serious pest of grain and sorghum in the Southern Plains. By damaging and often killing plants, it causes average annual losses estimated at $60 million.

Through experiments, the scientists developed a plant resistance index (PRI) for each wheat line. The PRI was based on the plants' tolerance to greenbug, their negative effect on greenbug biology, and their degree of preference by the greenbug.

The PRI was 90 for GRS 1201 and only 25 for Largo. The susceptible control, TAM W-101, had a PRI of 1.

This test revealed a much higher level of greenbug resistance in GRS 1201, which would make it a better source of resistance than Largo to breed new high-performance multi-greenbug-biotype resistant wheat cultivars.

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In the world of plants, green is usually good—except in canola seeds.

That's because too much green means too much chlorophyll in the seed.

Seeds may be mature, but if they're green, their market value drops. Freezing temperatures cause seed greening, and an early frost can cost North American canola growers $150 million.

Seed crushers have to remove the green from the oil with bleaching clays, which add expense and pose environmental problems.

ARS scientists are studying *Arabidopsis*—a close relative of canola—with the goal of identifying mutant plants that develop little or no seed chlorophyll. Some day, the researchers may be able to provide industry with transgenic canola, tailor-made to tolerate freezing temperatures.

Canola is an oilseed crop grown mainly in western Canada, with some acreage in Ontario and the Pacific Northwest, North Central, and Southeast United States. Its yellow flowers produce pea-shaped pods that contain tiny seeds harvested for their oil. The nutritional treasures in canola oil are its omega-3 fatty acids, acclaimed for improving human immune and vascular systems.

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Quarterly Report

of Selected Research Projects

United States Department of Agriculture
Agricultural Research Service

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Contact the scientists listed for further information on each research project. For general questions about this report, contact Hank Becker, ARS Information, 5601 Sunnyside Avenue, Beltsville, MD 20705, (301) 504-1624, hbecker@asrr.arsusda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact ARS Office of Technology Transfer, 5601 Sunnyside Avenue, Beltsville, MD 20705-5131. Questions about a company's product and/or research should be directed to the company itself.

This publication is available on the World Wide Web at http://www.ars.usda.gov/is/

Into the Marketplace

Mosquitoes are in trouble, thanks to a new trap that effectively attracts and kills them and biting flies.

ARS researchers co-developed the trap under a cooperative research and development agreement (CRADA) between ARS and BioSensory, Inc., of Willimantic, CT.

Registered under the trade name Dragonfly, the trap was named for the mosquito-hunting insect. It lures mosquitoes with a blend of carbon dioxide, heat, and octenol--the same chemical cues that attract biting insects in nature. Mosquitoes find their human and animal blood meals first by sensing carbon dioxide in breath, which they can detect up to 100 feet away. Mosquitoes also can find their prey by using heat sensors on their antennae.

The trap mimics the human or animal blood system, which helps lure them to the trap. The difference is that when mosquitoes home in on the target and stop to dine, they are killed with an electronic pulse and fall into a removable tray. That's a big advantage over traditional electrical bug-zapping traps that splatter the insect.

ARS researchers conducted field studies showing the trap's effectiveness in capturing mosquitoes. The attractants are registered with the U.S. Environmental Protection Agency for controlling mosquitoes and other biting insects.

ARS and BioSensory have a joint patent on the attractants used in the trap, with one patent pending. The trap should be commercially available this summer from BioSensory.

Center for Medical, Agricultural, and Veterinary Entomology, Gainesville, FL
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Licenses

. . .To ExSeed Genetics, LLC, Owensboro, KY, to use a new type of corn from ARS that boosts the health of animals–and the environment.

Unlike typical corn, the ARS-developed lines are low in phytic acid--a form of phosphorus that is unusable by pigs, poultry, fish, and other animals with one stomach. Phytic acid that ends up--undigested--in their manure, may contribute to phosphorus pollution of rivers and streams. Some evidence links that pollution to algal blooms and fish kills.

Low-phytic-acid corn from ARS, however, is correspondingly high in inorganic phosphate--the form of phosphorus that animals can easily digest and use for proper growth and healthy bones. Use of this superior corn should help growers comply with increasingly strict environmental regulations that limit pollution from manure. And, the new corn reduces the need for costly phosphorus supplements often required to ensure animals get enough of this essential nutrent.

ExSeed is incorporating the low-phytic-acid trait into its own proprietary lines of value-added

corn for sale to producers worldwide. (Patent No. 5,689,054)

Small Grains and Potato Germplasm Research Unit, Aberdeen, ID
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Cooperative Research and Development Agreements

. . . With Micro-Flo Company, Memphis, TN, to finish developing the next generation of biofungicides for controlling rot-causing fungi on apples, pears, and citrus after harvest.

As a result of ARS patents, the first generation of nontoxic biological coatings to replace synthetic chemicals was introduced in the United States 4 years ago. Under the new agreement, Micro-Flo and ARS scientists will optimize formulation of the second-generation biofungicide and fine-tune its application.

ARS and Micro-Flo researchers combined two bioactive substances with the yeast *Candida saitoana*. Innocuous to people, the yeast is a formidable competitor against fungi that attack fresh fruits. The bioactive substances are chitosan—a naturally occurring fiber found in some weight-loss products—and a synthetic sugar used as a glucose substitute.

Unlike the earlier biofungicides, the new coating stops fungi that already have a toehold on the fruit. In several years of tests in commercial packinghouses in California and Florida, the biofungicide proved as effective against rot-causing fungi as the two leading synthetic fungicides. Micro-Flo expects to have a product on the market within 2 years.

Appalachian Fruit Research Station, Kearneysville, WV
Charles L. Wilson, (304) 725-3451, ext. 330, cwilson@afrs.ars.usda.gov

. . . With the Grain Industry Alliance, which includes the American Institute of Baking and Kansas State University-Manhattan, to analyze the milling and baking qualities of hard red winter wheat and match those quality traits with the needs of foreign customers.

Flour samples from U.S.-grown hard red winter wheat varieties will be provided to 12 foreign cooperators. The cooperators will furnish feedback about how well these varieties meet the quality traits they need. In the United States, more hard red winter wheat is grown than any other kind, and 50 percent of all U.S. wheat is currently exported.

The CRADA joins federal and state research expertise with industry's ability to market a product. Because of this effort, U.S. wheat breeding is expected to increase its focus on improving quality for foreign and domestic markets. The expected outcome: a higher demand for U.S. wheat in foreign countries and a boost to the U.S. economy.

Grain Marketing Production and Research Center, Manhattan, KS
Don Koeltzow, (785) 776-2701, dek@usgmrl.ksu.edu

. . . With Trece, Inc., Salinas, CA, to study and test natural flower compounds as the basis for technologies that provide safer and more effective methods for controlling and monitoring moth pests of agriculture.

This will help farmers and agricultural consultants as well as other researchers.

The technologies will use natural airborne compounds, called volatiles, released by flowers of the Japanese honeysuckle, *Lonicera japonica*. ARS scientists discovered and patented (Patent No. 5,665,344) volatiles called cis-jasmone from these flowers. These natural chemicals attract a variety of adult Lepidoptera (moth) pests.

The larval stage of these pests causes yield losses, reduces crop quality, and increases production costs worldwide.

Currently, most monitoring systems use sex pheromones as baits for one gender--usually the male. But the ARS scientists found that cis-jasmone--alone or with other floral volatiles, particularly linalool or phenylacetaldehyde--attracts both sexes. The volatiles can be combined with other agents, such as Lepidopteran sex pheromones, feeding stimulants, or insect toxins.

Trece will analyze compounds and develop optimal formulas for commercially monitoring and controlling a broad range of moth pests. ARS and Trece will work cooperatively to screen the formulas and evaluate final selections in field tests.

South Central Agricultural Research Laboratory, Lane, OK
Sam D. Pair, (580) 889-7395, spair-usda@lane-ag.org

. . . With M&M Mars, Inc., Hackettstown, NJ, to develop environmentally compatible biocontrol systems for controlling major fungal diseases of cacao.

Researchers will focus on beneficial fungal microorganisms currently on the market, those in ARS collections, and newly isolated fungi from various cacao-growing countries.

The tropical cacao tree, *Theobroma cacao*, produces beans used to make chocolate. But three major fungal diseases--black pod rot, witches' broom, and frosty pod rots--caused by *Phytopthora, Crinipellis perniciosa,* and *Moniliophthora rorei*, can make the beans inedible or unusable. These fungal diseases have caused severe cacao yield losses and hardship for 5 to 6 million small farmers in South America, Africa, and Asia.

If cacao supplies do not increase for the year 2003 and beyond, a chocolate shortfall is forecast. Chemical controls for the fungi don't work very well and are expensive. Fungi-tolerant cacao cultivars are largely unidentified or have not been propagated in sufficient quantities.

ARS and Mars will study and test existing biocontrol agents that are available commercially (*Trichoderma virens* and *Burkholderia vietnamienis*) and those shown to have potential (*T. stromaticum* and *Cladobotryum amazonense*).

Biocontrol of Plant Diseases Laboratory, Beltsville, MD
Robert D. Lumsden/Prakash K. Hebbar, (301) 504-5682, rlumsden@asrr.arsusda.gov/ phebbar@asrr.arsusda.gov

Patents

. . . For a diagnostic test developed by ARS scientists for identifying animals in the early stages of a costly dairy cattle disease.

Mycobacterium paratuberculosis--the organism that causes Johne's disease--has been difficult to identify in its early stages with current laboratory tests. These tests can only detect the presence of an antibody. Because Johne's disease progresses slowly, it can take years before the immune system of an infected animal produces antibodies against the organism.

There is no cure for Johne's, which causes severe loss of milk production, diarrhea, and death. For this reason, dairy producers need to identify infected cows quickly and remove them from the herd. Johne's is spread within and among dairy herds by an infected cow passing the organism to an unborn fetus, by calves coming into contact with bacteria-laden manure, and by calves nursing an infected cow.

The newly patented test is based on a genetic sequence discovered by ARS researchers. It can pinpoint *M. paratuberculosis* from blood, tissue, and fecal samples. (Patent No. 5,985,576)

Zoonotic Diseases Research, National Animal Disease Center, Ames, IA
Judith R. Stabel, (515) 663-7304, jstabel@nadc.ars.usda.gov

. . . For a biodegradable spherical decoy to fatally attack apple maggot flies and other insect pests.

Hung in trees just outside orchards, the decoy is coated with sugar, high-fructose corn syrup, latex enamel paint and an insecticide. It may provide an alternative to repeatedly spraying trees and the apples on them with insecticide.

If not controlled, 1/4-inch-long, black-and-white-striped adult apple maggot flies can inflict millions of dollars in damage to orchards. They lay eggs just below the apples' skins. Maggots hatch and feed, creating tunnels through the apples, which begin to decay and then drop to the ground.

The decoy is designed to suit insects' preferences for color, shape, size, and surface texture. Apple maggot flies fall for an apple-size sphere painted black which, like a red apple, doesn't reflect ultraviolet light. ARS, the University of Massachusetts-Amherst, and the Biotechnology Research and Development Corporation, Peoria, IL, were granted a patent on the decoy.

Preliminary field tests in cooperation with Michigan State University showed the decoy has promise as a replacement for pesticidal sprays in blueberries as well. Commercial manufacture and sales of the decoys containing registered pesticides for use in the United States would require approval by the U.S. Environmental Protection Agency.

ARS is seeking an industrial cooperator to produce decoys for large-scale tests on the apple maggot fly and related insects such as the cherry fruit fly and the walnut husk fly. (Patent No. 5,720,968)

National Center for Agricultural Utilization Research, Peoria, IL
Michael R. McGuire, (309) 681-6595, mcguirmr@mail.ncaur.usda.gov

. . . For BEETLBAR, a new plastic barrier that blocks pesky beetles from boring into wood structures.

It will save poultry farmers money in losses from beetle-damaged broiler houses that cost thousands of dollars more to heat and cool than undamaged houses. Beetle-damaged insulation can cost more than $30,000 a house to repair.

ARS researchers developed this nontoxic barrier, which can be placed around trees, poultry house foundations, and a variety of residential, commercial, industrial, and farm buildings.

Two insects in particular pose problems for poultry farmers--

darkling beetles, also called lesser mealworms, and hide beetles. The larvae of these beetles develop in poultry litter and manure under high-rise poultry houses, then crawl up walls and posts into ceiling insulation, burrowing many holes and causing major structural damage. In Georgia and Virginia alone, annual losses from these insects are estimated at $9.8 million and $15.9 million, respectively.

BEETLBAR's slick surface prevents this migration. Another problem: Floor-reared birds feed on migrating beetles, which can harbor *Salmonella typhimurium*, *Escherichia coli*, tapeworms, and avian leukosis virus, leading to major economic losses for farmers.

The new barrier is strong, long lasting, lightweight, and easy to apply and clean. It is pesticide free and it reduces pesticides needed to control litter beetles.

ARS has filed for a patent on this new invention (Patent Application No. 09/216,513).

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cgeden@gainesville.usda.ufl.edu

. . . For an invention that can be used to genetically transform microbes or plants and holds promise for streamlining technology to make new, useful products from agricultural materials.

Using the technique on the fungus *Fusarium sporotrichioides*, ARS researchers have inserted a variety of multigene packages, or cassettes, into the fungus--producing several strains that are each capable of making a specific compound in abundance.

F. sporotrichioides is best known for releasing toxins into stored grains. Bbut someday genetically modified strains may do good works such as making vitamins, rubber, and drugs.

The inventors systematically synthesized and inserted gene packages into the fungus, creating strains that make large amounts of lycopene or beta-carotene. Lycopene gives red tomatoes their color, while beta-carotene is a vitamin precursor in carrots. Other carotenoids--zeaxanthin and astaxanthin--are used as food colorants, food supplements, or livestock and fish feed additives.

The advance is important because, until now, attempts to genetically engineer organisms to make large quantities of useful products have been limited to introducing only one or two highly expressed genes at a time. (Patent Application No. 09/360,083)

National Center for Agricultural Utilization Research, Peoria, IL
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. . . For producing and using natural yeasts or bacteria sprayed on grain plants' flowering heads to reduce severity of an important disease of wheat and barley up to 80 percent in field tests.

ARS scientists say the friendly microbes may work by gobbling up two compounds, choline and betaine, that are naturally present on flowering heads of grain, where they stimulate pathogen growth.

Then, when the wind blows disease-causing spores onto the flowers' male organs, little if any nourishment is left for the culprit fungi. The fusarium fungus may never gain a foothold to damage the developing kernel deeper inside the flower.

The disease, called head scab or head blight, reduced U.S. wheat yields in the 1990s by an estimated half-billion bushels.

Breeding of wheat and barley to resist the pathogenic fungi *Gibberella zeae* or *Fusarium graminearum* is still considered the best first-line defense against yield loss from head scab. But the biological control approach might someday limit the severity of infections, especially on crop varieties with some resistance.

ARS scientists are researching liquid fermentation media to economically produce the most effective microbes. (Patent Applications Nos. 09/414,097 and 09/414,200)

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Soil, Water, and Air Quality

Willow posts are a low-cost, environmentally friendly tool for controlling stream bank erosion and restoring degraded riparian plant communities.

Willow trees may be propagated by planting cuttings in moist soil. The cuttings develop roots and shoots and grow rapidly. Large 3-inch-diameter cuttings--called posts--are useful in controlling rapid erosion of stream channels.

However, low survival rates have been reported in certain areas of the country.

ARS and cooperating university scientists suspected that soil conditions might be the primary factor. To find out, they designed and conducted field studies of the relationships between soil conditions and survival and growth of willow posts planted along two rapidly eroding streams in Mississippi.

Plant vigor and growth were significantly lower for posts growing in soils that were too wet or too dry. Optimal conditions for growing posts were moderate elevations, about a half yard above the stream level at low flow. At this elevation, soils tended to have adequate moisture but frequent drainage.

The scientists also found a close relationship between soil texture and survival of willow posts. Posts growing in silty-clay soils had a low survival rate, decreased height, smaller leaf size, and lower leaf tissue chlorophyll content than those growing in sandy soils.

Since locations with well-drained, sandy soils and adequate moisture had high post growth and survival rates, targeting these zones will best ensure successful streambank restoration efforts using willow posts. Research continues on developing predictive tests for evaluating specific sites for planting willow posts.

National Sedimentation Laboratory, Oxford, MS
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ARS and Auburn University scientists are teaming up on a joint project to help cotton growers correct soil problems in the Tennessee Valley, which includes Tennessee and parts of Alabama, Mississippi, Kentucky, Georgia, North Carolina , and Virginia.

Although the land in this area is fertile, the soils are heavily eroded and heavily compacted, and plant roots don't extend deep into the soil. Years of conventional tillage, coupled with little crop rotation, have severely depleted the soil organic matter, in some areas to less than 1 percent. In field studies, ARS scientists found deep-tilling to 17 inches and planting a rye cover crop in fall increases yields and reduces soil compaction. Three-year average yields for this system were about 1,040 pounds of lint per acre.

The best conservation tillage treatment gave yields that were 14 percent higher than with conventional tillage and 18 percent higher than with no tillage without using a cover crop, the system Tennessee Valley farmers adopted when they first went to conservation tillage.

At current prices for cotton, fall deep tillage in combination with a rye cover crop paid for itself more than three times over.

National Soil Dynamics Laboratory, Auburn, AL
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Food Safety and Quality

By discovering a secret about the way *Salmonella enteritidis* cells communicate with each other, ARS scientists may be a step closer to foiling this food-poisoning microbe.

Laboratory studies revealed that this type of salmonella uses a chemical called acyl-homoserine lactone in a primitive form of cell-to-cell communication that enhances, by as much as 100 times, the cells' ability to grow. Cases attributed to *S. enteritidis* in eggs have quadrupled in America in the past 20 years. The pathogen causes a diarrheal disease, salmonellosis. Scientists have known since the late 1960s that microorganisms can use chemicals to communicate with each other--a phenomenon known as quorum sensing. But the ARS work was the first to show that *S. enteritidis* uses acylhomoserine lactone for that purpose and that the chemical is a major factor in the pathogen's ability to contaminate eggs and to spread.

Meanwhile, USDA's new Hazard Analysis and Critical Control Points inspection system for food-processing plants helps keep salmonella in check.

Southeast Poultry Research Laboratory, Athens, GA
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Mangoes could become even more popular with U.S. consumers, thanks to natural compounds.

U.S. consumption of mangoes increased about 77 percent from 1993 to 1998. More than 95 percent of mangoes sold here are imported from Mexico and Central and South America.

ARS researchers have found they can protect the whole fruit

against chilling injury during storage and keep fresh-cut slices from browning and drying.

When the thermometer dips below 50 °F, mango skin becomes pitted and discolored, and the flesh darkens and becomes susceptible to decay.

But methyl jasmonate--a sweet-smelling compound derived from jasmine and other plants--prevents chilling injury and dramatically improves overall fruit quality, compared to untreated fruit.

Researchers gave mangoes a whiff of methyl jasmonate for 24 hours at 68 °F before storing the fruit for 2 weeks at 41 °F.

The treatment didn't alter normal ripening and softening processes or increase water loss. And it worked on fruits at various stages of maturity.

Methyl jasmonate is safe and relatively inexpensive.

Mangoes could be an attractive addition to the growing market for fresh-cut produce, but browning and drying have prevented such marketing.

Using food-safe compounds derived from natural products, the researchers preserved fresh-cut mangoes for 2 weeks when stored at 50 °F. They treated the slices with a combination of hexylresorcinol, isoascorbic acid, and potassium sorbate. Then they stored the slices in plastic containers to prevent drying.

Horticultural Crops Quality Laboratory, Beltsville, MD
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Winemakers and food and drink processors may be among the first to benefit from new technology to quickly and easily identify spoilage yeasts.

ARS scientists and researchers at Boston Probes, Inc., Bedford, MA, used the company's patented technology to develop a test kit that detects unwanted yeasts among filter-collected microbial cells. In their part of the joint project, the ARS scientists obtained and provided information on unique DNA sequences in 500 representative strains of all known yeasts classified as *Ascomycetes*.

Their effort was the first attempt to develop a commercial use for a genetic blueprint database of an entire set of microbes.

Now the ARS researchers are genetically analyzing representative yeasts in the 80,000-sample ARS Culture Collection to find how closely certain species or strains are related.

An understanding of the strains' links is important to epidemiologists, as well as to companies trying to protect their patents and to researchers who want to predict a microbe's usefulness for industrial purposes.

Meanwhile, the new test kit is expected to help food and drink processors detect build-ups of unwanted fermentation microbes and correct the condition before massive amounts of a product must be discarded.

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Animal Production and Protection

Cattle breeders keep track of certain characteristics of their animals in order to select animals with the best combination of desired traits.

But "best" has been a subjective and inconsistent measure. Now, thanks to ARS research, breeders may refine their decision-making by focusing on profitability. To assess their animals, breeders keep track of growth traits, such as weights at birth, weaning, yearling, and maturity.

They also measure carcass traits such as lean yield, marbling, and fat content, which are indicators of value to consumers. In addition, they record traits like the age when a female reaches puberty and her subsequent pregnancy.

Breed associations take the information, combine it with each animal's genetic tree, and run it through a computer program to develop an expected progeny difference, or EPD. That lets breeders compare individual animals for individual traits. They would know, for example, that bull A was more likely to produce offspring with the desired marbling than bull B.

But until now, the process has not been complete: Producers were left with the difficult task of combining the EPDs in an efficient manner.

A refined system devised by an ARS geneticist allows breeders to use the EPDs to predict genetic potential for profit.

With this system, breeders will be able to know how to most

profitably trade off such features as changes in fat thickness and marbling.

The complicated calculations are not yet available in a simple computer program for individuals to use. Their developer says producers will most likely get the information through Cooperative Extension Service specialists or breed associations as the lab passes on the technology.

Fort Keogh Livestock and Range Research Laboratory, Miles City, MT
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Dairy producers could benefit from an enzyme supplement--for their cows.

Bromelain, a mix of enzymes extracted from the stems of pineapple plants, helps keep the white cell count in cows' milk down in the range that fetches a premium price, according to a recent ARS study.

U.S. dairy producers get an extra 20 cents per 100 pounds for milk having a cell count under a specified level. That level ranges from about 200,000 to 300,000 cells per milliliter, depending on which state tests the milk. Producers can't sell milk with cell counts above the legal limit. In the United States, that's 750,000 cells/ml.

Canada and Europe have lower limits--500,000 and 400,000, respectively.

In the study of 10 cows with average white cell counts slightly over 300,000, putting 75 grams of bromelain pellets daily in each cow's feed reduced cell counts by 100,000 on average during each of two trials. What's more, cell counts never surpassed the legal U.S. or Canadian limits when the cows got bromelain, as they sometimes did when left untreated. With bromelain, producers could have more days with cell counts in the premium price range--under 300,000.

Immunology and Disease Resistance Laboratory, Beltsville, MD
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Mixing tiny glass beads with catfish feed helps researchers do a better job of measuring how much feed the fish consume.

Until now, it's been difficult to measure how much food an individual fish eats daily, because all fish are raised together in a pond and fed simultaneously. Generally, catfish producers record feed intake based on simple observation, but this method assumes that fish consume all the feed delivered and that they all eat the same amount.

ARS researchers adapted the new, innovative technique from salmon feeding studies--using tiny glass beads in the feed--and customized it for channel catfish. The opaque glass beads, about 0.4 millimeters in diameter, are mixed in low concentrations of about 1 percent of the feed.

After feeding, catfish are anesthetized and x-rayed. This allows the beads to be counted so that an accurate calculation of feed consumed by each fish can be made.

In indoor tank studies, scientists found different catfish strains consume feed at different rates. Fish with superior feed intake and conversion of feed into filet meat can be identified, so this trait can be incorporated into breeding programs.

The researchers have perfected the technique even more by automating the bead- counting process. This allows scientists to view 600 scanned x-ray images a day, versus 200 images over a few weeks when done by hand. Automation is nearly 100-percent accurate.

Catfish Genetics Research Unit, Stoneville, MS
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Healthier and more productive cows that produce more profits for farmers and more abundant, higher quality milk for consumers is the goal of an ARS research project to map dairy cattle genes.

The project integrates research from two key ARS animal labs: one that keeps tabs on traits like milk, fat, protein, and others that affect cows' health, vigor and profitability; and another that studies genes related to growth, disease resistance, and milk productivity.

By wedding findings of both labs, researchers will integrate newly identified molecular markers with existing data sources to more accurately evaluate dairy animals' traits and to speed up the rate of genetic improvement. As a result, genes influencing important traits like mastitis resistance, milk yield, and fat and protein concentrations will be easier to identify and use in breeding decisions.

Using genetic markers in estimating the genetic value of dairy cattle can accelerate the rate of improvement for milk production and other economically important traits.

Animal Improvement Programs Laboratory/Gene Evaluation and Mapping Laboratory, Beltsville, MD
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Human Nutrition

If you're between the ages of 18 and 44, chances are you didn't get enough vitamin K today . . . or any other day, according to a recent survey.

Long known for its role in blood clotting, vitamin K is gaining recognition for its importance to the integrity of bones: It activates at least three proteins involved in bone health.

Researchers at the ARS nutrition research center in Boston and the Proctor & Gamble Co. collaborated to estimate vitamin K intake from a nationwide sample of 4,742 men, women, and children. Their findings: People over age 65 consumed more phylloquinone--the most common form of vitamin K--than 20- to 40-year olds.

Only half the females age 13 and older, and less than half the males, got the Recommended Dietary Allowance, based on food intake diaries the survey volunteers kept for 14 days. The RDA is 65 micrograms per day for adult females and 80 mcg/day for adult males.

Phylloquinone is found in some oils, especially soybean oil, and in dark-green vegetables such as spinach and broccoli. One serving of spinach or two of broccoli provide four to five times the RDA.

Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University, Boston, MA
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Chances are you'll get more antioxidant protection from eating fresh fruits and vegetables than from taking natural product supplements claiming to be potent antioxidants.

That's according to analyses of 46 commercial preparations by the ORAC assay.

ORAC—short for "oxygen radical absorbance capacity"—measures the ability of a chemical or biological sample to disarm oxygen free radicals that can cause wear and tear on the body's DNA and cell parts. ARS researchers found the total antioxidant capacity of 40 berry-based supplements ranged from 16 to 3,985 ORAC units—a 249-fold difference.

The supplements tested in cluded bilberry, cranberry, chokeberry, and elderberry extracts. Six other antioxidant products having grape seed or pine bark extracts or pycnogenol ranged from 16 to 8,392 ORAC units—a 525-fold difference. The findings remind consumers that there are no industry standards for the antioxidant capacity of natural product supplements and thus little assurance of a high-quality product.

The researchers point out that a single serving of fresh or freshly cooked fruits or vegetables supplies an average of 300 to 400 ORAC units. Many fruits and vegetables—such as berries, plums, oranges, leafy greens, and beets—provide much higher antioxidant levels. By contrast, 28 of the 40 berry extracts tested and one of the 6 other products wouldn't provide 300 ORAC units in a day's suggested intake.

Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University, Boston, MA
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Kids who play a video game called "Squire's Quest!" may end up eating more fruits and vegetables.

Scientists at the Children's Nutrition Research Center are testing this experimental game with 1,600 Houston schoolchildren as part of an innovative new nutrition education program.

Right now, America's kids eat only about two to three and one-half servings of fruits and vegetables a day instead of the five to nine servings recommended for optimal mental and physical growth and development.

The video game is part of a series of ten 25-minute classroom sessions in which kids make tasty "virtual" recipes using fruits and veggies, then set personal goals for making those recipes at home and for eating at least one additional serving of a fruit or vegetable at a meal or snack.

Kids playing the game are squires training to become knights who can save the imaginary kingdom of "Five-A-Lot" from invaders that want to destroy its fruits and vegetables.

Scientists expect to finish evaluating the effectiveness of the education experiment by the end of this summer.

USDA-ARS Children's Nutrition Research Center at Baylor College of Medicine, Houston, TX
Tom Baranowski, (713) 798-6762, tbaranow@bcm.tmc.edu

Crop Productivity

Using an enzyme from green algae, ARS researchers are exploring new ways of improving photosynthesis in soybean plants.

Photosynthesis is the process by which plants use energy from sunlight to make their food--carbohydrates--from carbon dioxide (CO_2) and water. Rubisco is a key enzyme in the process because it captures CO_2 from the air.

But in soybeans, rubisco sometimes also captures oxygen. This happens about 20 percent of the time, scientists estimate, keeping the plant from peak photosynthetic performance. That, in turn, can deprive the plant of more energy for growth and production of seed prized for their high-quality, edible oil and protein.

Soybean crops now yield about 39 bushels per acre and generate $9.89 billion annually. But scientists believe an even higher seed yield can be achieved.

In the lab, they're testing this theory by genetically replacing the natural rubisco of soybean plants with an enzyme from the green algae species *Chlamydomonas reinhardtii.* The latter's enzyme captures CO_2 more quickly, they found.

If successful, their approach could mean transgenic soybeans with a more "selective" appetite for CO_2 instead of oxygen.

Besides improved productivity, the enzyme-substitution technique might also help soybeans to exploit higher CO_2 levels associated with global climate change.

Photosynthetic Research Laboratory, Urbana, IL
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Tropical corn from Mexico and Central America could become an alternative cattle feed to sorghum in the South.

Dairy cows ate so much more tropical corn silage that they produced 10 to 20 percent more milk than when fed sorghum.

Silage is a fermented, moist feed for wintertime.

In steers, tests of its nutritional value showed it to be slightly less digestible than forage-type sorghum. But the steers ate more of the tropical corn, evening out the digestibility difference.

What's more, tropical corn yields about 87 percent more dry matter than sorghum, making each acre more productive.

Farmers usually plant sorghum when it gets too wet or too late in the season to plant temperate corn. In the southern United States, where long days and a long growing season substitute for its native climate, tropical corn is a good alternative because it grows well in heat and tolerates insects.

Its season: Plant in June, harvest in October. Alternating tropical corn and a winter crop for ensiling in the spring--such as winter wheat or barley--would protect the ground from erosion and give cows two quality feeds.

ARS plans to work with a university economist to see if this approach would produce extra money for farmers. If so, it might become an even more attractive alternative to sorghum.

Plant Science Research Unit, Raleigh, NC
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An intensive 3-year survey found that at least 635 different species of Lepidoptera (moths and butterflies) inhabit the Marine Corps Air Station Miramar in San Diego County, CA.

Information from the survey of the approximately 23,000-acre air station will be used by insect identifiers, taxonomists, ecologists, integrated pest management specialists, conservationists, and biological resource managers.

Lepidoptera play an important role in pollination. Many of them are economically important pests of crops and ornamentals, and the adults and larvae provide food for countless other invertebrates as well as larger animals.

Among the species documented during the survey were at least 12 moths previously unknown to science. In addition, scientists found one butterfly (*Lycaena hermes* or Hermes copper) that is recognized as "sensitive" and declining by the U.S. Fish and Wildlife Service.

Two moths--*Dryadaula terpsichorella* and *Metapluera potosi*--had never before been found in the United States. The survey was conducted from October 1995 through September 1998 and orchestrated by an ARS scientist.

Sampling methods included blacklight trapping for 364 nights, daytime collecting for 148 days, and pheromone baiting.

It's likely the air station's lepidopterans are even more diverse than the scientists have documented; they estimate that, in all, nearly 700 to possibly more than 900 species call the station home.

Inventories such as this document the rich biological heritage of the United States.

Systematic Entomology Laboratory, Washington, DC
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Fumigating walnuts with sulfuryl fluoride kills any codling moths or navel orangeworms that would like to hitchhike on the freshly harvested nuts.

The chemical might replace the methyl bromide fumigant now being used but is slated for withdrawal from use by 2005.

ARS scientists at Fresno, California, are the first to show the potential of sulfuryl fluoride as a methyl bromide alternative for fumigating walnuts. Sulfuryl fluoride fumigation might help America's walnut growers keep European sales strong. European Union nations are key importers of American walnuts, but they currently require methyl bromide fumigation of the shipments.

Unlike methyl bromide, sulfuryl fluoride is not thought to contribute to depletion of Earth's protective ozone layer.

Sulfuryl fluoride is already approved as a structural fumigant but is not yet OK'd for food uses. By exposing lab-reared codling moths and orangeworms to vacuum-chamber fumigation, the scientists found that using slightly more than 0.001 ounce of sulfuryl fluoride per liter of air kills these insects.

Other fumigation experiments, using some 2,500 walnuts artificially infested with codling moths in their wormlike larval stage, indicated that using seven times less sulfuryl fluoride than methyl bromide killed 100 percent of the codling moth larvae.

The Walnut Marketing Board helped fund the research.

Horticultural Crops Research Laboratory, Fresno, CA
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Industrial (Nonfood) Products

New products and more market demand for alfalfa and soybeans can be expected by Midwest farmers in the 21st century.

An ARS agricultural engineer working with University of Wisconsin scientists have devised a method to fractionate soybean and alfalfa herbage in the field. Fractionation is the physical separation of herbage into a number of parts, each having properties and uses different from the original material.

Until now, wet fractionation was conducted in a central processing facility. The drawback: Herbage, which contains about 80 percent water, had to be transported from the field to the processing facility. Waste liquid then had to be either dehydrated or transported back to the field as liquid fertilizer.

In the summer of 1999, the researchers performed the first fieldside demonstration of soybean wet fractionation. For the most part, commercially available machines were used, but a hammermill--originally used for pulverizing grain by forcing it through screens--was modified to rupture the herbage without reducing fiber size.

Next, the researchers will develop a mobile field processor. Working like a combine, it could cut the crop and wet-fractionate it while juice is being processed in the field. In this demonstration, the energy cost for producing 6.4 tons of herbage and 3.5 tons of juice per hour was about 76 cents per wet ton.

Potential products from the fiber portion include cattle feed, chemical feedstocks, mats for filtering pollutants from water, enzymes derived by growing fungi on the fiber, and building materials. Products from the juice fraction include food- and feed-grade protein concentrates, carotenoids, antioxidants, and industrially valuable enzymes.

The work was done under a CRADA with industry.

U.S. Dairy Forage Research Center, Madison, WI
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Trace levels of iron can now be detected in biological samples in 2 minutes.

Developed by ARS scientists, the new procedure makes use of a special chemical, called a pyoverdine, produced by the

beneficial bacterium *Pseudomonas fluorescens*. Under ultraviolet light, pyoverdine normally takes on a greenish- yellow glow that quickly subsides as iron is absorbed.

But ARS scientists saw a strikingly different scene when they mixed a solution--called an acetate buffer--with pyoverdine and added the combination to test samples containing as little as 10 parts per billion of iron. Instead of quickly subsiding, the glow steadily increased for several minutes. And the more iron that was present, the slower the rate of increase.

Pyoverdine could be put into a simple kit that could be used to monitor increased iron levels in urine as patients are treated with an antimalarial drug. Or someday the chemical may become part of more sophisticated tools--fiber-optic biosensors--that could monitor iron levels during water, food, pharmaceutical, and chemical processing.

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Crop Diseases and Pests

Scrutiny of root-nibbling pathogens, plucked from strawberry roots in one of the nation's leading strawberry-producing regions, will provide new clues about how to foil these destructive crop pests.

Scientists are determining the abundance and virulence of soil-dwelling pathogens *Pythium* and *Rhizoctonia*. This should help them develop new tactics for killing these and other microbes. New weapons are urgently needed because strawberry growers' most effective tool--methyl bromide fumigant--is being phased out.

The researchers are sampling microbes from commercial strawberry fields along the central coast of California--the nation's No. 1 producer of strawberries. *Pythium* and *Rhizoctonia* microbes that scientists are examining cause a strawberry disease known as black root rot and can also infect lettuce, tomatoes, cauliflower, and many other plants.

Severity of strawberry plant symptoms varied greatly when researchers used field samples of the microbes to infect greenhouse strawberry plants.

Pythium ultimum--the most prevalent *Pythium* at field sites-and *P. irregulare* were among the *Pythiums* causing the most damage to greenhouse plants.

But several other *Pythium* species that were brought in from the strawberry fields caused few if any symptoms.

In contrast, nearly every *Rhizoctonia* form recovered from the field significantly reduced growth of the greenhouse-grown strawberry plants.

Crop Improvement and Protection Research Unit, Salinas, CA
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Genetically engineered peanuts may offer a new defense against one of the legume crop's most costly foes: the larvae of lesser cornstalk borers.

Unchecked by soil insecticides, the pests eat pods that house the peanut plant's seeds, rendering them inedible.

To deter such attacks, ARS and university researchers genetically engineered peanut plants to make a protein from *Bacillus thuringiensis* (Bt) bacteria.

Borers that ingest the plants' *Bt* proteins generally stop attacking or starve.

In 1998 field tests, 90 percent of the *Bt* peanuts escaped serious pod damage from borer attack compared to an unaltered control group.

Scientists are now analyzing data from a second round of tests from last summer. Commercial peanuts bred from such plants could help cut insecticide use, prevent aflatoxin contamination by *Aspergillus* fungi, and slow the cornstalk borer's ability to overcome resistant cultivars that are now available.

Insect Biology and Population Management Research Laboratory, Tifton, GA
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Sugarbeet growers may soon get a new tool for identifying six major types of fungi that can seriously damage their crop.

Using polymerase chain reaction (PCR) technology, ARS scientists have developed a way to quickly identify six kinds of fungi that can cause multimillion-dollar losses in U.S. sugarbeets. The whole diagnostic process can be completed within 8 hours.

PCR reproduces millions of copies of the unique segments of fungal DNA that occur in a plant tissue sample. With this amplified DNA, the researchers

can quickly distinguish the pathogens according to their DNA "fingerprints," generated when the DNA is cut into pieces with an enzyme.

By using PCR, scientists don't have to isolate fungi from diseased roots or leaves and spend days culturing them before they're identified.

Rapid DNA identification of offending microbes would tip growers off to the need for control measures before fungal diseases seriously curtail yields.

Now, ARS scientists are narrowing down DNA identification even further, to identify species as well as genera.

Already the scientists can distinguish *Aphanomyces cochlioides*, which causes black root disease of sugarbeet from *A. euteiches*, which causes root rot in peas and other legumes.

Other fungi that attack sugarbeets include *Pythium ultimum, Cercospora beticola, Phoma betae, Fusarium oxysporum,* and *Rhizoctonia solani.*

Sugarbeet and Potato Research, Fargo, ND
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ARS scientists have begun a 3- to 4-year project to find ways to combat the tarnished plant bug, *Lygus lineolaris*, a major cotton pest that cost growers $75 million last year.

The study covers a 36-square-mile area in the Mississippi Delta region, consisting of four 9-square-mile areas, with a possibility of future expansion.

In 1993, an ARS researcher discovered tarnished plant bugs had become resistant to pyrethroids, a class of insecticides commonly used to control them. There are more than 100 different weed species on which tarnished plant bugs can feed and reproduce.

In the winter, they lie dormant in weeds surrounding cotton fields and emerge from February or mid- to late March and begin laying eggs in the weeds. In late spring, they move into cotton crops when the weeds mature.

ARS scientist are investigating several different approaches to controlling plant bug populations, including controlling weeds, using biological controls, and developing a chemical lure called a pheromone.

It has been know for several years that the female produces a pheromone that attracts mostly males. However, in field tests last summer, ARS scientists discovered that the males may produce a pheromone that attracts both sexes--probably to signal food sources--but they are repeating the test this summer to make sure. Tarnished plant bugs are the only major pest in cotton for which scientists don't have a sex pheromone. Once they develop one, they'll be much closer to banishing the pest from cotton fields.

Southern Insect Management Research Unit, Stoneville, MS
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IPM/Biocontrol

A tiny weevil that attacks melaleuca, an invasive tree, is now thriving in at least 50 sites in south Florida.

That's thanks to work by ARS researchers in Australia and Florida, who recruited the grey-brown *Oxyops vitiosa* weevil to stop the spread of melaleuca, also known as paper-bark tree.

The scientists conducted more than a decade of tests, necessary to prove that the quarter-inch-long weevil won't attack other plants. In 1997, the scientists won regulatory approval for the first-ever outdoor releases of the weevil in America. Both melaleuca, a relative of the familiar bottlebrush plant, and the melaleuca leaf weevil are native to Australia, but neither is a pest there.

In Florida, melaleuca invades an average of 14 to 15 acres every day. At one release site, the original 1997 colony of 3,300 weevils had burgeoned to about 80,000 weevils when scientists checked it again in 1999.

They relocated about 20,000 of the weevils to some 30 new sites in Florida, meaning that researchers have now placed the helpful weevils in every part of melaleuca's Florida range.

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A natural protein from a soil fungus may help control broadleaf weeds like yellow star thistle, dandelion, and northern joint vetch.

ARS researchers discovered the protein, called Nep1, in secretions of the fungus *Fusarium oxysporum.*

Some *Fusarium* strains cause crop diseases. But Nep1 plays no part in *Fusarium's* disease-causing machinery, scientists showed. Yet, when purified and sprayed onto weeds like dandelion, Nep1 becomes a natural herbicide. It quickly penetrates leaf openings called stomata and starts a biochemical chain reaction. This triggers the leaf's cells to commit mass suicide. Three to 24 hours later, the leaf is dead, but not the weed's apical buds, stem, or roots.

Sprayed as a natural herbicide, Nep1 could help weaken a weed's dominance over crops, grasses, or other plants that normally can't compete. Nep1 mainly affects dicot (or broadleaf) weeds such as dandelion, yellow star thistle, sow thistle, and northern joint vetch.

Though not intended for dicot plants like cotton, researchers speculate Nep1 could be used as a natural defoliant for easier harvesting of lint fiber.

Since Nep1 is made of amino acids--a basic building block of proteins--it should be innocuous to humans and animals and break down in the environment.

Biocontrol of Plant Diseases Laboratory, Beltsville, MD
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Some Florida vegetable growers are getting better yields in winter crops by relying on the sun instead of treatments with methyl bromide to eliminate weeds and pests.

As an alternative to methyl bromide treatment, an ARS scientist enlisted several growers to test soil solarization--covering the soil under clear plastic for at least 6 weeks during summer to "cook" weed seeds, diseases, and some nematodes. Before the winter crop is planted, the plastic is painted white to cool the soil enough for tender roots.

In 1998, yields from solarized fields ranged from 96 to 123 percent of yields from methyl bromide-treated fields on three commercial farms. The pepper field yielding 123 percent had been deep-disked before solarization to break up stubble and bring nematodes to the surface so heat would destroy them.

Two solarized pepper fields on another farm yielded 118 and 104 percent. Both had been beefed up with a biosolids compost. It was the second year of solarization for the field yielding 104 percent and the third year for the field yielding 118 percent, suggesting that solarization may gradually raise yields.

Solarization saved the business of the only organic grower in the study. In his second year of solarization, production rose 30 percent, labor dropped 75 percent, and profits jumped 100 percent.

But solarization has drawbacks: It works only for fall planting--half the crop in the deep South--and it doesn't adequately control all pests. Plus, growers must start preparing field beds at least 6 weeks before planting, posing logistic problems for large operations.

U.S. Horticultural Research Laboratory, Ft. Pierce, FL
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Nearly one-third of Washington's apple and pear now rely on nonchemical pest management tools, thanks to a 5-year USDA-sponsored research program targeting codling moths and other pests.

Washington supplies more than half of the nation's commercial apples. Young codling moths are the infamous "worms in the apple." Uncontrolled, they could destroy 80 percent of northwest apples and half the pears.

ARS set up the Codling Moth Areawide Suppression Program in 1994. It relies on ARS- and university-developed technology for confusing the moths with sex attractants, or pheromones, so they cannot find a mate. This tactic is supplemented with intensive monitoring and limited pesticide spraying and relies on extensive grower participation.

Previously, growers sprayed up to 6 times per year for codling moth and 4 to 6 times for leafrollers, aphids, and other secondary pests. This meant using 2 million pounds of insecticides annually at $60 to $150 per acre.

With integrated pest management, or IPM, pesticide use has fallen at least 70 percent, and control is more successful. The scientists showed that using commercial insecticides can still leave 1 or 2 percent of the apples damaged by insects.

With IPM, this drops to less than 1 percent and in some cases as low as 1 apple in 10,000.

Mating disruption is now used on at least 60,000 acres in Washington and another 8,000 acres in California, Colorado, and Oregon.

ARS' research partners include Washington State University-

Pullman, Oregon State University-Corvallis, and the University of California-Berkeley.

Yakima Agricultural Research Laboratory, Wapato, WA
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Natural parasitic fungi could become biological controls for diamondback moths and Russian wheat aphids.

The diamondback moth attacks cabbage, broccoli, canola, and other crucifers. Each year, farmers worldwide spend more than $1 billion to control it, primarily with chemical insecticides. But in many areas the moth has become resistant to conventional insecticides as well as to natural bacterial controls like *Bacillus thuringiensis*, or Bt.

The aphid is a major pest of U.S. winter wheat and barley.

Since invading the United States about 1986, the pests have cost growers more than $850 million in insecticide treatments, crop yield losses, and other expenses.

ARS scientists have run laboratory and field tests that show the moth succumbs to both fungi--*Beauveria bassiana* and *Paecilomyces fumosoroseus*. But only *Beauveria* had a consistent impact on aphids in the field.

ARS scientists and colleagues at Cornell University were the first to field-test Mycotrol, a commercial formulation of *B. bassiana*, against the diamondback moth. Weekly or twice-weekly applications significantly reduced insect populations and damage to seedlings, compared to chemical controls.

Other scientists have shown that different strains of *B. bassiana* work against the Russian wheat aphid in the lab.

But this is the first report of Mycotrol's field effectiveness against this aphid.

Mycotrol was first developed to combat silverleaf whiteflies through a CRADA between ARS and Mycotech Corp. Butte, MT.

U.S. Plant, Soil, and Nutrition Laboratory, Ithaca, NY
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Plant Genetic Resources

Genetically fingerprinting the plant material used to prepare St. John's-wort can guarantee consumers that they are getting their money's worth of this herbal product.

St. John's-wort is a widely used dietary supplement that is popularly taken as an antidepressant. Various species of the genus *Hypericum* contain many of the chemical constituents of St. John's-wort, but only the flowering tops of *H. perforatum* are supposed to be used in its preparation.

Today, adulteration of commercial preparations often occurs, due mainly to the use of species other than *H. perforatum*.

ARS scientists developed a molecular technology that uses genetic markers to reveal the identity of the plant material.

Using these markers, they were able to detect contamination in seed packages sold as *H. perforatum*. This was possible because differences among the DNA sequences of the various *Hypericum* species can be detected in the form of genetic fingerprints.

The continued public acceptance of herbal dietary supplements largely depends on the ability of manufacturers and regulatory agencies to ensure that botanical preparations are safe and appropriately labeled.

In the current regulatory environment, the safety of herbal products is tightly linked to the positive identification of their ingredients.

ARS scientists developed the technology in response to the Food and DrugAdministration's request for means to guarantee the authenticity of St. John's-wort.

Natural Products Utilization Research Unit, Oxford, MS
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Genes needed for breeding superb new lesquerella plants for tomorrow might be easier to find, thanks to a simple new technique for extracting genetic material from this hardy native perennial.

Oil from *Lesquerella fendleri* could reduce America's reliance on imported castor oil needed for lubricants, coatings, plastics, paints, lipstick, shampoo, and other products. To find genes that would enable tomorrow's lesquerellas to flourish on salty soils or to yield higher quantities of oil, for instance, scientists must decode the plant's genetic material.

But procedures used successfully in biotech labs worldwide to coax DNA from other plants haven't worked with

lesquerella. That's because its natural gums, or polysaccharides, form large pellets that firmly trap DNA inside.

Now, a procedure from ARS scientists sidesteps this sticky problem by putting ground-up leaf tissue through a series of simple steps, including 10-minute and 15-minute spins at low or moderate speeds on the centrifuge.

The procedure, adapted from an approach developed elsewhere in 1983, takes about as much time as conventional techniques for pulling out plant DNA--yet doesn't require harsh solvents.

What's more, the new method might be ideal for extracting DNA from other high-polysaccharide plants like peanuts, cucumbers, or muskmelons.

A member of the mustard family, lesquerella is native to Arizona, New Mexico, Colorado, Utah, Texas, and Mexico.

U.S. Water Conservation Laboratory, Phoenix, AZ
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Flooding injuries to soybeans have been found to be caused by a buildup of carbon dioxide--not by a lack of oxygen in waterlogged soils, as previously thought.

This discovery by an ARS scientist has led to a greenhouse test to aid breeders in selecting flood-tolerant varieties. It screens soybean seedlings for flood tolerance based on their response to a 30-percent carbon dioxide (CO_2) solution.

Nontolerant soybeans either stop growing or die, while tolerant soybeans show less signs of injury.

In the field, CO_2 concentrations in air trapped in waterlogged soils were found to be as high as 50 percent; soybean yield losses became significant after exposure to 30-percent concentrations.

For the new test, seedlings are placed in plastic pouches and dunked in a nutrient solution through which CO_2 is bubbled.

A prototype system is being tested that uses special cameras to sense plant reactions to high CO_2.

These reactions include drooping leaves, less root and shoot growth, and a yellowing that eventually deteriorates to black spots as tissue dies. When fully automated, the system could screen thousands of seedlings in a few weeks.

Soil Drainage Research Unit, Columbus, OH
Tara T. VanToai, (614) 292-9806, tvantoai@magnus.acs.ohio-state.edu

A DNA marker that can help breeders select flood-tolerant soybeans has been found.

The marker is near genes that make soybean plants so flood-tolerant that they yield 50 percent higher after flooding than nontolerant plants. In both 1997 and 1998, 280 soybean lines were field-tested, growing in completely waterlogged soils for 2 weeks at the flowering stage.

The work is being done jointly by ARS scientists and colleagues at the University of Arkansas-Fayetteville, University of Utah-Salt Lake City, and Ohio State University-Columbus. The scientists are also part of a national soybean genome mapping project partly funded by the United Soybean Board.

For confirmation of the yield increase in the field, selected plants having the marker will be field-tested in Arkansas and Ohio. Field and greenhouse tests are being used to find germplasm lines containing additional genes that may account for further yield increases in flooded fields.

Soil Drainage Research Unit, Columbus, OH
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ARS scientists have found the largest number of new *Penicillium* species discovered by any person or group since the genus was first described in 1809.

They accomplished this by sampling molds where penicillia are usually not sought--and by using modern biotechnological tools.

Until now, researchers have focused mainly on *Penicillium* from moldy food, moldy livestock feed, and soil samples. Working with a collection of 600 molds that parasitize wood-decaying fungi, scientists found 39 *Penicillium* species new to science.

To confirm that they were new, the researchers used an automated DNA sequencer to compare the particular sequences of genes in the molds with sequences in archived penicillia.

Then they added the new species to the ARS Culture Collection's 102 previously known *Penicillium* species, including those that scientists used to help launch the antibiotics industry a half century ago.

The addition of new species to the collection will help scientists learn more about the genus from which penicillin is obtained. And by using gene sequence information to improve identification and comparison, the researchers are better equipped to find more useful *Penicillium* isolates from nature.

National Center for Agricultural Utilization Research, Peoria, IL
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Jade peas, or edible vegetable soybeans, can be eaten just like green peas.

Now, a new type of jade peas called BARC-18 can give farmers a crop they can tailor to their individual taste, needs, and growing conditions.

ARS geneticists bred a vegetable soybean to a vigorous, tall-growing forage soybean to develop BARC-18. It provides soybean growers with source material for developing their own vegetable-type soybean of superior vigor for a variety of local conditions.

Vegetable and soybean growers can use BARC-18 to develop their own, unique lines.

BARC-18 produces a wide variety of plant types--tall and short, large and normal-size seed, early- and late-maturing, green seeds, and yellow or pale-cream seeds. Growers can select plants with suitable characteristics and preferred eating qualities after they grow selections of the plants for three generations.

To cook jade peas, just boil them for about 3 minutes, pop them from their pods and season to taste.

Seeds of BARC-18 have been sent to more than 25 growers, along with detailed instructions on growing and selecting offspring, preparing the soil, and cooking the beans.

BARC-18 has genes for exceptional plant height and vigor, large seed size, green seed coat, and green embryo. It also has genes for resistance to lodging--toppling over as a result of wind or rain.

The scientists developed BARC-18 by crossing the vegetable-type soybean Verde with several forage-type soybeans.

Weed Science Laboratory,
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Dozens of natural chemicals that inhibit the growth of two important grain-infecting molds have been extracted from 600 parasitic molds isolated from wood- decaying fungi.

ARS and University of Iowa scientists--with support from the National Science Foundation and the Biotechnology Research and Development Corporation (BRDC), Peoria, IL--found the chemicals have novel molecular structures that work against either the aflatoxin-producing *Aspergillus flavus* or fumonisin-producing *Fusarium verticillioides* (formerly known as *F. moniliforme*).

From the collection of 600 molds, the scientific team has produced hundreds of extracts that BRDC has distributed to companies, including its own members. The companies have been screening the extracts for chemicals that might serve as agricultural pesticides, animal health products, and antifungal antibiotics.

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Quarterly Report of Selected Research Projects

USDA United States Department of Agriculture

ars Agricultural Research Service

January 1 to March 31, 2000

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Contact the scientists listed for further information on each research project. For general questions about this report, contact Hank Becker, ARS Information, 5601 Sunnyside Avenue, Beltsville, MD 20705, (301) 504–1624, hbecker@asrr.arsusda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact ARS Office of Technology Transfer, 5601 Sunnyside Avenue, Beltsville, MD 20705–5131. Questions about a company's product or research should be directed to the company itself.

This publication is available on the World Wide Web at http://www.ars.usda.gov/is/

Into the Marketplace

A newly signed master memorandum of understanding between USDA and the State of Hawaii should enhance coordination and cooperation between state departments and USDA agencies in the 50th state, including ARS research laboratories located there.

The memorandum, apparently the first of its kind between USDA and Hawaii, seeks to boost the productivity of Hawaii's farms and strengthen its rural communities, among other top-priority goals.

Despite the decline in sugarcane and pineapple production in Hawaii, agriculture remains of critical importance to that state.

ARS research, along with the expertise of other USDA agencies, is helping Hawaii in the transition from plantation agriculture to more independent, diversified farms producing exotic crops for lucrative mainland and overseas markets.

The new agreement will be in effect for 5 years.

Crop Production, Product Value, and Safety, Beltsville, MD
Kenneth W. Vick, (301) 504–5321, kwv@ars.usda.gov

Cooperative Research and Development Agreements

...With Gustafson LLC of Plano, TX, to develop new transplant mixes for tomato and pepper seedlings that will reduce yield losses caused by soilborne pathogens.

ARS researchers and cooperators have developed a transplant mix that will help tomato and pepper farmers combat soilborne pathogens such as root-knot nematodes.

The transplant mix, BioYield™213, incorporates two naturally occurring soil microorganisms—*Paenobacillus macerans* and *Bacillus amyloliquefacien*—that stimulate vigorous growth and improve the health of transplanted seedlings by triggering defense mechanisms in the host plant. This makes the seedlings more tolerant of stresses caused by low water or nutrient levels. This translates into 5 to 20 percent yield increases for tomato, bell pepper, and strawberry growers.

BioYield™213 will be commercially available to transplant producers in the fall after grower trials are concluded. This new research has helped scientists determine that alternative soil treatments such as Telone II and PLANTPRO 45 are also effective when they are

combined with the new transplant mix technology.

This research is part of an ongoing ARS effort to provide farmers with alternatives to the use of methyl bromide, an ozone-depleting soil fumigant to be phased out by 2005.

U.S. Horticultural Research Laboratory, Ft. Pierce, FL
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...With The Xerces Society, Portland, OR, to enhance populations of native insect pollinators—especially wild bees—on America's golf courses.

In conjunction with the U.S. Golf Association's pioneering "Wildlife Links" program, ARS scientists and Xerces Society staff will determine how to establish—on roughs or other out-of-play areas of golf courses—vegetation hospitable to an array of pollinating insects. The Xerces Society is an international, nonprofit conservation organization.

ARS scientists are making recommendations about species of native flowers, trees, shrubs, and other greenery that could be planted to meet the pollinators' needs for nectar, pollen, and nesting sites. The scientists are also providing nest blocks to attract pollinating bees and are conducting insect censuses at the participating golf courses.

When established, the replanted areas should add diversity to the often uniform golf course vegetation. In addition, these zones may become important reservoirs of native bees that could pollinate plants in small agricultural plots adjacent to the courses or backyard gardens nearby.

ARS Bee Biology and Systematics Laboratory, Logan, UT
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...With Ocean Spray Cranberries, Inc., Lakeville, MA, to scrutinize species of bees that might be adept at pollinating cranberries.

These alternative pollinators might help with the enormous job of pollinating the 20 million flowers per acre of bog that healthy cranberry plants produce every spring.

The key pollinator of American cranberry fields, the domesticated *Apis mellifera* honey bee, has been hard hit by varroa and tracheal mites, small hive beetles, and the pathogenic microbes that cause American foulbrood, chalkbrood, and other diseases.

ARS bee researchers in Logan, UT, along with colleagues at Ocean Spray, are hunting for native bee species that excel in pollinating cranberries. The scientists then plan to develop information that commercial beekeepers can use to produce and manage populations of these bees for work in commercial cranberry bogs.

Once used primarily for the familiar garnish at year-end holiday feasts, cranberries today are also in demand for juice, juice blends, and a raisinlike snack, as well as other products.

One of the few crops native to America, cranberries are a good source of vitamin C. Wisconsin, Massachusetts, New Jersey, Oregon, and Washington lead the nation in cranberry production. The 1998 cranberry harvest of 544,400,000 pounds was worth more than $211 million to U.S. growers.

ARS Bee Biology and Systematics Laboratory, Logan UT
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...With Novartis Seeds, Inc., Boise, ID, to quantify tomato flavor components and establish criteria for the selection of new lines.

In response to the public's growing dissatisfaction with the flavor of fresh tomatoes, ARS researchers and cooperators are investigating ways to improve it.

Before deciding what varieties are more apt to grow into tastier tomatoes, researchers use chemical and sensory analyses—including an electronic "nose"—to identify the compounds that give tomatoes their distinctive flavor.

Preliminary indications are that the most critical flavor components are a variety of aldehydes and ketones—both highly reactive organic compounds—as well as other volatiles, sugars, and acids. Methanol and ethanol are also

important because they enhance the perception of other flavors.

The researchers will be evaluating industry handling practices, which often diminish the fruit's flavor potential. These include harvesting "immature green" tomatoes along with "mature green" ones and storing or transporting the tomatoes at too low a temperature. Identifying and quantifying important flavor compounds and quantities could also lead to a commercial flavoring agent.

Citrus and Subtropical Products Laboratory, Winter Haven, FL
Elizabeth A. Baldwin, (861) 293–4133, ext. 119, ebaldwin@citrus.usda.gov

...With Pioneer Hi-Bred International, Inc., Johnston, IA, to evaluate corn hybrids for resistance to aflatoxin accumulation.

Aflatoxin is produced by the fungus *Aspergillus flavus* and has food safety implications. ARS scientists evaluated corn hybrids designed to resist infection by *A. flavus* and aflatoxin accumulation at two locations in Mississippi in the summer of 1999.

In turn, Pioneer will evaluate the same hybrids for yield and other agronomic qualities, as well as resistance to fumonisin accumulation.

This partnership should expedite the development and marketing of corn hybrids with high yield potential and resistance to aflatoxin accumulation. Contamination of corn grain with aflatoxin can be a devastating problem for farmers, especially during severe drought conditions.

Growing resistant hybrids is generally considered the most feasible method of eliminating the problem. Currently, there are no aflatoxin-resistant hybrids commercially available.

Corn Host Plant Resistance Research, Mississippi State, MS
W. Paul Williams, (662) 325–2735, pwilliams@dorman.msstate.edu

....With Sparktec Environmental Inc., Stoney Creek, Ontario, Canada, to develop pulsed power pressure technology that will improve the quality and safety of meat products.

Pulsed power pressure technology works on the same principle as a spark plug. A large electrical charge of 5,000 volts or more is directed between two electrodes that are submerged in water. This produces a high-energy plasma arc, which in turn produces a pressure shock wave that is directed to the meat product, also submerged in the water.

Controlling foodborne pathogens and thereby reducing their potential health risks in meat products is considered one of the most important issues facing meat producers and processors throughout North America and Europe.

Secondary to food safety is meat tenderness, which affects consumers' acceptance of a product. Inconsistency in tenderness exists from one animal to another, from one piece of meat to the next, and within the same piece of meat.

Sparktec will provide a plasma sparker unit to ARS and train researchers to operate the equipment. Technical support throughout the CRADA will be provided by Sparktec.

ARS researchers will supply the meat products, develop experimental protocols, and collect the data from the experiments. They will also characterize the effect of pulsed power discharge pressure on muscle tissue and assess the effect of this treatment on spoilage and pathogenic microorganisms on meat products.

Together, ARS and Sparktec will develop applications of pulsed power pressure technology for successful commercial use for meat tenderization and food safety.

Meat Science Research Laboratory, Beltsville, MD
Morse Solomon, (301) 504–8400, msolomon.lpsi.barc.usda.gov

Soil, Water, and Air Quality

Adding sodium carbonate—a harmless ingredient in soft drinks and some toothpastes—could be a practical and inexpensive method for treating dairy cattle manure to decrease *Escherichia coli* O157:H7 and other potential pathogens.

Some cattle harbor *E. coli*: O157:H7 and other disease-causing bacteria that can persist in manure for long periods of time. But a team of ARS and Cornell University-Ithaca scientists found that adding sodium carbonate can kill many of these harmful microbes.

Laboratory tests showed that although *E. coli* was resistant to alkaline pH and ammonia, it was very sensitive to carbonate if the pH was alkaline. Carbonate can be derived from urine when urease—an enzyme in feces—breaks down urinary urea, trapping some carbon dioxide as carbonate. Urinary carbonate alone can kill *E. coli*, but cows don't make enough urine to kill all the *E. coli*.

The team made its discovery by mixing manure and urine. When the ratio was 1 to 1, virtually all of the *E. coli* bacteria were killed. But dairy cows typically excrete 2.2 times as much feces as urine, and *E. coli* persisted at that ratio—unless the cow manure samples were spiked in the lab with sodium carbonate.

Laboratory experiments indicated that carbonate killed other bacterial pathogens, as well, such as *Salmonella typhimurium, Streptococcus pyogenes, Klebsiella pneumoniae*, and *Staphylococcus aureus*.

The researchers also added some sodium hydroxide to ensure that the pH was at least 8.5. After only 5 days, the *E. coli* count was less than 10 cells per gram in manure samples—down from the original 100,000 to 100,000,000 counts per gram.

Cattle manure is often stored outdoors in large tanks or ponds prior to spreading on fields, but a threefold dilution with water did not diminish the effectiveness of carbonate treatment.

The estimated cost of this treatment would be only $10 per dairy cow per year. However, pilot and farm-scale testing will be needed before the technology can be recommended to the livestock industry.

U.S. Plant, Soil, and Nutrition Laboratory, Ithaca, NY
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Using seismic/acoustic waves to describe important soil physical properties is relatively new to soil science.

The description of how soil particles touch each other and are arranged in soil is also of great interest and can be deduced from these waves. The advantage of the seismic/acoustic technique over traditional methods is its ability to identify the magnitude of these properties without disturbing the soil.

The key, ARS scientists say, is how well the soil absorbs these waves. They've developed a technique that lets them measure absorption of these waves, penetrating up to 4 inches of the upper soil profile.

The seismic technique is especially useful for measuring the swelling or shrinking condition of soils, since the status of the soil can be changed by its water content. The scientists applied the seismic technique to a Mississippi Delta Sharkey clay soil, known for its high swelling/shrinking capacity. They found large changes in the velocity of seismic/acoustic waves in this soil as a result of its water content.

From this information, scientists can determine the elasticity of the soil. When fully developed, this new technology could be used in agriculture and in highway and building construction. The technology could also be used someday to monitor the moisture content in fields so automated sprinkler systems would turn on only when the soil needed watering.

National Sedimentation Laboratory, Oxford, MS
Mathias J. Romkens, (662) 232–2927, romkens@sedlab.olemiss.edu

ARS scientists studying water quality in America's streams hope to find lots of healthy bugs.

Scientists are finding that small aquatic invertebrates are excellent and inexpensive indicators of water quality.

Some, like *Hyalella azteca*, can even be used to measure how much of any pollutant

is acceptable in our surface water.

The 1/8- to 1/4-inch crustacean, commonly found in lakes, ponds, and streams throughout North America, consumes decaying plant material. It can be found swimming in the water or burrowing into sediment.

It's an important link in the aquatic food chain and a food source for several predators, such as fish and various invertebrates.

Using *Hyalella* as an indicator of environmental quality has many advantages. It has been well studied; scientists know its life history, behavior, growth, reproduction, and the effect of different factors on its survival. It is easily raised and reproduces rapidly and is an inexpensive organism that is easy to work with.

This crustacean provides researchers with a biological measurement of stream health, in addition to chemical and physical measurements.

National Sedimentation Laboratory, Oxford, MS
Charles Cooper, (662) 232–2935, cooper@sedlab.olemiss.edu

Cracking and swelling soils can have a profound effect on the hydrology of watersheds.

ARS scientists studying the genesis, morphology, and underlying mechanisms of crack development found that, depending on the degree of dryness or size, cracks may absorb all incoming rainwater.

Also, the presence of cracks will affect the absorption and deposition of surface-applied agrichemicals and rainfall-detached soil particles.

This research showed that besides intrinsic soil characteristics, soil surface conditions, such as type of cover, also play a significant role in the manner of crack development.

In this laboratory study, the breakdown and compaction of soil aggregate by raindrops falling on the unprotected surfaces led to a stratification in the upper 0.4 inches of the soil profile.

The surface seal had different mechanical properties than the substrate and therefore affected crack development. Most of the water infiltration and soil movement took place in and through those cracks.
On protected soil surfaces, such as those covered with mulch, cracks developed as well, but infiltration was more uniform.

National Sedimentation Laboratory, Oxford, MS
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An increased demand for rapid extraction and analysis of pesticide residues has led ARS scientists to develop a new analytical chemistry technique.

Their fast and sensitive gas chromatographic method uses sonication (sound agitation) for extracting atrazine (triazine herbicide) and lambda-cyhalothrin (pyrethroid insecticide) from sediment and aquatic plant samples. This method requires less chemical solvent and smaller samples than standard U.S. Environmental Protection Agency methods.

Since newer analytical equipment is not always available, the researchers reevaluated and updated older methods that use more traditional equipment. They discovered that, for optimal pesticide recovery, sediment and plant samples should be wetted with water prior to the addition of extracting solvents.

Analytical chemists studying herbicide and other pesticide residues in sediment and plant samples will use this information.

National Sedimentation Laboratory, Oxford, MS
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Q_R

Food Safety and Quality

A new electrostatic air cleaning system reduced airborne salmonella by 94 percent in a commercial hatchery in Georgia in a recent ARS study.

Hatching cabinets are a primary source of salmonella contamination for broiler chickens.

A single infected chick can spread salmonella to all of the chicks in a hatching cabinet.

The new system captures dust that harbors hitchhiking organisms such as salmonella.

Dust is electrostatically charged and captured on special plates that are automatically washed at prescribed intervals.

Results of the most recent commercial experiments showed a 77 percent reduction in dust levels on average and 94 percent less enterobacteriaceae (commonly encountered bacteria such as salmonella or *E. coli* that frequently cause disease) than a cabinet treated with hydrogen peroxide disinfectant.

The system has also been shown to reduce airborne *Salmonella enteritidis* in a caged layer room by 95 percent and to have a strong killing effect on salmonella at close range.

Southeast Poultry Laboratory, Athens, GA
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A jellyfish gene is helping researchers discover how a food-poisoning bacterium, Escherichia coli O157:H7, can colonize fresh lettuce.

An ARS scientist has inserted a gene from the *Aequorea victoria* jellyfish into laboratory strains of this foodborne pathogen.

The gene cues production of a bright-green, fluorescent protein.

When leaves of romaine, green leaf, and iceberg lettuces are artificially infected with the genetically engineered *E. coli* for laboratory investigations of the pathogen, the fluorescence acts as a readily detectable marker, making it faster and easier to spy on the microbe.

The fluorescence-based assay should help food safety scientists test the effectiveness of new tactics designed to keep *E. coli* out of food. Though outbreaks of *E. coli* O157:H7 linked to contaminated lettuce are infrequent, researchers want to help growers, processors, and consumers ensure that the popular leafy vegetable remains safe to eat.

Earlier, other researchers moved the fluorescence gene into other organisms. But the ARS team is among the first to employ fluorescing *E. coli* O157:H7 to track this microbe's movements in plant tissue.

E. coli O157:H7 can cause bloody diarrhea and in some instances can lead to acute kidney failure, requiring patients to undergo dialysis.

The microbe is unusual in that most other bacteria in the same family are harmless to humans.

Food Safety and Health Research Unit, Albany, CA
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Animal Production and Protection

Tons of a nutritious mix that's left over from rearing sexually sterile Mediterranean fruit flies make a safe, nourishing, and highly digestible feed for livestock.

ARS and University of Hawaii scientists have shown that this recycling of the leftover material, called "spent diet," could help solve the costly problem of its disposal.

Spent diet is generated when insectaries rear millions of medflies. The insects are sterilized, then used to prevent wild, fertile medflies from gaining a foothold in warm-weather states like California and Florida.

When sterile males mate with their wild female counterparts, no viable offspring result, so the population crashes.

The caramel-to-brown spent diet looks something like moist sawdust or dried oatmeal and contains water,

wheat germ, sugar, yeast, and milled wheat bran or milled corncobs.

A medfly factory run by USDA's Animal and Pl^!L Health Inspection Service in Hawaii is currently shipping spent diet to North Shore Cattle Co., Haleiwa, HI. The insectary provides about 300 million sterile medflies every week for medfly control in southern California and generates about 12,000 pounds of the leftover food every day.

Some foreign insectaries already recycle their leftovers as feed, but the ARS and University of Hawaii study is the first to provide data needed for the commercial trial with cattle in Hawaii. University researchers are monitoring the effect of the new rations on livestock weight gains.

U.S. Pacific Basin Agricultural Research Center, Hilo, HI
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Human Nutrition

Body cells are constantly barraged with chemical signals that pester them to respond. Miraculously, they do a pretty good job of filtering out the "noise" and staying on purpose.

But some cells lose the ability to regulate these signals and they react before they should.

Researchers now believe this loss contributes to chronic diseases, such as cancer and heart disease. For example, if an order to divide gets "heard" by too many cells, it could lead to unrestrained growth as in cancer or an overactive immune system.

Test-tube studies more than a decade ago showed that a phytonutrient in soy foods—genistein—dampens communication from the cell's surface to its interior.

How well does it work in the animal? For 4 weeks, an ARS scientist fed young rats diets containing soy protein with high or low levels of genistein.

Then she measured how the animals' blood platelets responded to chemical signals.

Platelets are quite sensitive to outside signals and so are a good model for studying cell signaling. In three different tests, the platelets from the animals receiving the high-genistein diet were less activated, suggesting that genistein and other isoflavones may reduce over-responsive signaling that produces chronic disease.

The genistein-rich diet had the equivalent of twice the average Japanese genistein intake. And the Japanese have a lower incidence of cancer and heart disease. The genistein-poor diet contained the equivalent of the U.S. intake. Tofu, tempeh, and miso are some soy foods rich in genistein and other isoflavones.

Nutrient Requirements and Functions Laboratory, Beltsville, MD
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A little extra cholesterol in our diets may render the "bad" LDL cholesterol in our bloodstream more susceptible to oxidation.

That was the outcome of a study with 13 older men and women with moderately high cholesterol—that is, greater than 130 milligrams per deciliter. Evidence suggests that oxidized LDL cholesterol is more apt to provoke the plaques that build up in arteries and increase risk of heart attack and stroke.

The volunteers ate 30-percent-fat diets that differed only in the type of fat and the amount of cholesterol. Otherwise the foods were identical. One diet was rich in polyunsaturated fat from corn oil; the other was rich in saturated fat from beef tallow. To compare the effect of increasing dietary cholesterol on blood cholesterol, the researchers added around 220 to 330 milligrams of cholesterol—depending on the volunteer's total calorie intake—to each diet.

The type of fat didn't significantly affect the susceptibility of the volunteers' LDL cholesterol to oxidation in a test-tube assay. But the extra cholesterol increased oxidation susceptibility by 28 percent during the corn

oil diet and 15 percent during the beef tallow diet. It also prompted a further rise in the volunteers' total—as well as LDL—cholesterol, regardless of the type of fat in the diet.

USDA Human Nutrition Research Center on Aging at Tufts University, Boston, MA
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Are your blood lipids higher than your doctor would like? If you are also overweight—with a body mass index (BMI) between 25 and 30—you'll probably benefit more from cutting those extra pounds than from cutting dietary fat.

That's the gist of a study done in Spain by researchers at the University of Cordoba Medical School and at the ARS center in Boston.

Two different heart-healthy diets were less effective at improving the cholesterol profile of overweight men than of normal-weight men. Total cholesterol in the overweight men dropped less than half that of the lean men—7 versus 16 percent—after switching from a diet high in total fat and saturated fat to one recommended by the National Cholesterol Education Program (NCEP).

Likewise, artery-damaging LDL cholesterol dropped 9 percent in the overweight group versus 21 percent in the lean group. The NCEP diet is low in fat—28 percent of total calories—with only 10 percent saturated fat.

A second heart-healthy diet also had less impact on total and LDL cholesterol in the overweight men. Although this diet was high in fat—38 percent of total calories—more than half of it (22 percent) was monounsaturated fat, the predominant fat in olive or canola oils.

However, this diet produced a much bigger drop in triglycerides in the overweight group, compared to the lean group: 26 percent versus 4 percent. High triglycerides are associated with reduced glucose tolerance, the earliest stage of diabetes. And evidence is mounting that high trigylcerides independently increase risk of heart disease, say the researchers.

Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University, Boston, MA
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Tortillas and other foods made with flour from an unusual ARS-developed corn may help combat iron-deficiency anemia.

That could benefit not only people in developing countries where tortillas are a part of nearly every meal, but also people in developed countries who don't get enough iron.

The unique corn is low in phytic acid, or phytate. Phytic acid is thought to reduce the body's ability to use iron and certain other nutrients. The ARS corn lines have up to about 66 percent less phytic acid that most common varieties.

A study with 14 healthy men showed that iron absorption by those volunteers was about 50 percent greater if they ate tortillas made with flour of the low-phytic-acid corn than if they ate tortillas prepared with normal corn flour that contained about two-thirds more phytic acid.

Scientists from the Institute of Nutrition of Central America and Panama and from the University of California's Berkeley and Davis campuses conducted the tortilla test, in collaboration with ARS. Now, scientists from the University of Colorado are leading an investigation that will determine if the low-phytic-acid corn boosts absorption of zinc in a group of Guatemalan villagers.

The research is perhaps best known for its environmental benefits. One-stomached animals like pigs, chickens, or farm-raised fish that are fed the low-phytic-acid corn have significantly less phosphorus in their manure, because the corn provides a form of it they can readily digest and use. The corn thus helps reduce the load of unused phosphorus that could leach into rivers and streams, perhaps contributing to algal blooms and fish kills.

ARS has patented the corn and licensed it to three companies.

Small Grains and Potato Germplasm Research Unit, Aberdeen, ID

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A new study to define the antioxidant needs of people with spinal cord injuries should also help clarify the nutrient requirements of other, less severely injured individuals.

The investigation, apparently the first of its kind, will determine whether paralyzed people need more antioxidant nutrients, such as vitamins A, C, and E, or beta-carotene, a compound that the body uses to make vitamin A. The findings could also be applicable in determining the antioxidant requirements of people who have injuries that leave them sedentary for months at a time or who are gradually losing their mobility because of worsening arthritis, for example.

ARS and University of California-Davis scientists aim to work with 75 northern California adults with spinal cord injuries to learn about their eating habits and to test their antioxidant levels. The findings may help paralyzed people live longer and healthier lives.

Right now, Americans with spinal cord injuries live only about 80 percent as long as their peers.

Though America's dietary guidelines address the needs of many groups, including the young and the elderly, very little research has been done on the special nutrient requirements of those with paralysis.

Gunshot wounds and car, motorcycle, or swimming pool accidents are among the leading causes of spinal cord injuries in the United States today. The Paralyzed Veterans of America Spinal Cord Research Foundation, Washington, DC, is funding part of the study.

Western Human Nutrition Research Center, Davis, CA
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Crop Productivity

Just released by the Agricultural Research Service: Soyola—a nontransgenically modified soybean for the southern United States yields oil that doesn't need to be hydrogenated.

Hydrogenation produces the bulk of dietary trans fats now recognized as unhealthy for the heart.

Soyola would be ideal for frying and salad oil markets. Its oil has half the linolenic acid found in commercial varieties. This polyunsaturated fatty acid degrades easily and causes the "off" or rancid flavors in soybean oil, especially after extended heating. So most soybean oil is now hydrogenated to stabilize it for cooking and extend its shelf life.

The plants yielded as well as or better than the commercial cultivars Brim and Dillon during 2 years of tests at 10 locations. Soyola is suited for North Carolina, South Carolina, Virginia, Tennessee, Kentucky, southern Missouri, northern Alabama, Mississippi, and Arkansas. Seed will be available from N.C. Foundation Seeds, 8220 Riley Hill Rd., Zebulon, NC 27597.

Soybean and Nitrogen Fixation Research Unit, Raleigh, NC
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An ARS scientist has identified a soybean yield barrier that, when breached, promises yield potentials of more than 100 bushels per acre.

Under normal spring temperatures, full-season soybean varieties grown in the Midwest begin flowering around the first week of July, almost 2 weeks after the June 21 summer solstice, when days start growing shorter and light intensity declines. Exceptionally early warm spring temperatures can trigger flowering in soybeans 2 weeks earlier than normal, bringing the reproductive stage earlier in the growing season when light intensity is higher and increasing the length of the reproductive cycle. This has resulted in irrigated yields above 100 bushels an acre.

If breeders can develop earlier-flowering full-season varieties that will begin flowering around the middle of June under normal spring

temperatures, the yield potential of soybeans could be increased 15 to 20 bushels an acre. This translates to $75 to $100 more per acre at today's prices.

In the meantime, researchers recommend that farmers plant soybeans earlier. The photo/thermal (day length/temperature) barrier to higher soybean yields was first hypothesized by the researcher in 1982, when May temperatures averaged about 64 degrees F—the highest May average since the Ohio maximum yield experiments began in 1977.

The 1982 yield averaged 89.4 bushels per acre across 64 soybean lines in the study, and 4 lines exceeded 100 bushels. Most years, the yields are 70 bushels per acre, with some lines yielding 80.

In 1998, a similarly warm May gave the researcher a chance to test his hypothesis—and it was confirmed. The yield averaged 80.7 bushels an acre, with some lines over 90. In 1999, with an average May temperature of 62 degrees F, compared to a long-term average of 58 degrees F, yields were 90 bushels per acre again.

Corn and Soybean Research Unit, Ohio Agricultural Research and Development Center, Wooster, OH
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Experimental plots at Wooster, OH, that are equipped for both drainage and subirrigation, yielded more than 100 bushels an acre of soybeans in 1999, compared to a nonirrigated yield of 50 to 60 bushels.

The secret is the marriage of two ideas developed by ARS scientists at Ohio State University: irrigating through drainage pipes to maintain the water table throughout the growing season, coupled with a high-yield soybean production system. The high-yield system involves early planting of ARS-developed semidwarf soybean varieties in narrow rows at a dense seeding rate. While the record yields don't occur every year, the past 14 years of research with the merged techniques promise consistent annual yields of 70 to 80 bushels an acre.

The combined practices also caused a significant increase in experimental corn yields in 1999 because dry conditions greatly lowered yields on fields that were drained but not irrigated—228 versus 131 bushels per acre. Although the practices haven't led to record yields for corn as they have for soybeans, the yield increase in dry years could pay for the cost of modifying the drainage system to irrigate.

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Atemoya and sugar apple trees needed no handpollination when sap beetles were enlisted in greater-than-usual numbers to visit the blossoms.

The enlistment incentive: yeasty-smelling bread dough and sap beetle attractants, called pheromones, like those ARS scientists had discovered and then synthesized for successful experiments to monitor and control sap beetles in crops where they are pests. University of Florida and ARS researchers loaded pheromones and bread dough into bait stations in flowering sugar apple and atemoya trees. Stymied by screens that kept them out of the stations, the beetles moved on to pollinate blossoms.

Atemoya and sugar apple, tropical relatives of the Midwestern native pawpaw, are noted for their delicate mango- and vanillalike flavor and custardlike pulp.

The sap beetles—*Carpophilus* or nitidulid species—that pollinate the trees also sporadically inflict multimillion-dollar damages to many of the world's other minor crops such as figs, dates, and stone fruits. However, no nitidulid pheromones have yet been developed for commercial use.

National Center for Agricultural Utilization Research, Peoria, IL
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Saving the world's chocolate crop from pathogenic fungi is the goal of ARS scientists working with a team of international experts.

They're using natural controls and other tactics to protect the tropical cacao tree, *Theobroma cacao*. Chocolate is produced from cacao tree beans. For every dollar of U.S. cacao bean imports, about $1.50 worth of other agricultural commodities are used to make chocolate confections.

But three major fungal diseases—black pod rot, frosty pod rot, and witches' broom—can make the beans inedible or unusable. The diseases have caused severe yield losses, causing hardship for 5 to 6 million small farmers in South America, Africa, and Asia. If supplies do not increase for the year 2003 and beyond, a shortfall is forecast.

Chemical controls for the fungi don't work very well and are expensive, and fungi-tolerant cultivars are largely unidentified or have not been propagated in sufficient quantities.

But ARS scientists have identified and are testing beneficial *Trichoderma* fungi that control the bad fungi. In the first year of field trials in Peru, scientists sprayed a mix of five strains of *Trichoderma* on flowers and pods of trees infected with frosty-pod disease, Peru's main cacao disease. The mix increased pod yields more than each strain used alone.

In Brazil, researchers are testing new *Trichoderma* species. One, *T. stromaticum*, reduced pod infection by witches' broom fungus by 31 percent. ARS scientists are investigating how this *Trichoderma* works and seeking more economical methods for mass-producing it.

The international effort, coordinated by ARS, includes the American Cocoa Research Institute, McLean, VA; M&M Mars, Inc., Hackettstown, NJ; and several international research groups.

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Industrial (Nonfood) Products

Scientists with ARS and Vision Paper, Inc., of Albuquerque, NM, have rolled up their sleeves and dirtied their hands to find new uses for "black liquor," a crude byproduct of pulping kenaf fiber.

Black liquor is usually burned for fuel or chemical recovery, but often small paper mills can't afford expensive incinerators. The researchers found that chitosan, made from ground-up crab shells, helps transform the dissolved kenaf lignin into a solid cake.

Next, the solid cake will be tested as an animal feed pellet binder. The remaining soluble black liquor can be converted to a low-sodium, dry fertilizer containing about 22 percent nitrogen. In the overall process, black liquor is turned into salable products instead of greenhouse gases.

Originally from Africa, kenaf is a fast-growing, renewable fiber crop closely related to cotton.

Twenty-five years ago, ARS scientists developed a process to turn kenaf into newsprint.

Kenaf is currently being grown on 12,000 acres in Georgia, Texas, and Mississippi. U.S. farmers can grow it instead of corn, soybeans, cotton, or rice.

National Center for Agricultural Utilization Research, Peoria, IL
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Natural rubber latex films made from a southwestern desert shrub called guayule are an effective barrier against disease-causing bacteria and viruses, according to preliminary tests by ARS and Food and Drug Administration researchers.

The findings mean that surgical gloves, condoms, or other medical, home, and industrial products made

from guayule's hypoallergenic latex may offer a safe, practical alternative for the estimated 20 million Americans allergic to latex products from the most common source, the Brazilian rubber tree.

Prototype patient-examination gloves and condoms made of Arizona-grown guayule latex, formed to the same thickness as commercially produced gloves and condoms made from Brazilian rubber tree latex, passed standard virus-permeability tests, according to the scientists.

A test virus known as *phi* X174— especially chosen for its small size—could not slip through the guayule latex. The virus is smaller than bacteria and is the same size, or smaller than, human pathogenic viruses such as HIV, hepatitis B, and herpes simplex.

The researchers reported their findings in a recent issue of the *Journal of Biomedical Materials Research.*

ARS scientists were the first to show, in 1994, that guayule latex is free of the allergens that can cause severe reactions such as anaphylactic shock or even death.

Crop Improvement and Utilization Research Unit, Albany, CA
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Crop Diseases and Pests

Biotechnology can take years off the development of disease-resistant corn varieties.

ARS researchers have cloned a part of a well-known gene, *glutamine synthetase,* that targets expression of antifungal genes in the tip of the kernel. To resist infection with aflatoxin or fumonisins, a corn plant needs the action of antifungal genes targeted in the tip of the kernel, where aflatoxin and fumonisins gain entry during hot weather.

These carcinogens may render a crop unfit for animal or human consumption. Resistant plants could be developed in less than a year, compared to the 7 years it takes to breed varieties with traditional methods. The work was funded by ARS and the Biotechnology Research and Development Consortium in Peoria, IL.

National Center for Agricultural Utilization Research, Peoria, IL
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A lost South American tribe of insects may give scientists new clues for predicting the potential losses caused by leafhoppers, pests of many crops.

The new information is of interest to researchers studying the relationships among leafhoppers to better predict their pest potential. It's also important to federal and state workers at ports of entry; they need to recognize species not indigenous to the United States.

Each year, leafhoppers cause hundreds of millions of dollars of crop losses worldwide. More than 170 species of these pests transmit diseases to crops like rice, corn, celery, and cranberries.

Now, an ARS scientist and Venezuelan colleague are describing a new genus and species (*Jaita tachirensis*) of leafhopper from the Andes mountains of Tachira, Venezuela. This is the first record of the tribe Megophthalmini in the New World south of Mexico.

The tribe is a widespread group of uncertain origin. It may prove invaluable in constructing a classification that makes it possible to accurately predict biological traits of unstudied species from those of studied species that are closely related.

This information is needed to effectively judge the pest potential of many leafhopper species.

Construction of a predictive classification of leafhoppers is hampered by a major gap in knowledge of various groups, including the Megophthalminae. But the scientists have described how the lost tribe has affinities to other New

World Megophthalminae, including the Chilean tribe, Evansiolini.

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IPM/Biological Control

Spinosad, an environmentally friendly insecticide, may become a widely accepted alternative to the malathion sprays used today for battling Mediterranean fruit fly.

ARS tests in Hawaiian coffee fields showed that even though malathion insecticide gave the best results in controlling medfly, spinosad and another promising malathion alternative—a red dye known as phloxine B—also gave impressive levels of control.

The results also suggested that spinosad and phloxine B may need to be applied more frequently than malathion, but the total amount of active ingredient released into the environment using spinosad or phloxine B would be far less.

In addition, one of medfly's important natural enemies—the tiny *Fopius arisanus* wasp—was significantly less susceptible to spinsosad or phloxine B than to malathion. The wasp is harmless to humans.

The Hawaii tests were one of the most extensive field studies ever conducted on the effect of the three chemicals on medfly and the beneficial wasp.

Medflies can attack more than 200 fruit, vegetable and nut crops and pose a constant threat to agriculture in warm-weather states such as California, Texas, and Florida.

Spinosad is already approved for use on more than 100 crops, including apples, almonds, citrus, eggplant, tomatoes, and cotton.

U.S. Pacific Basin Agricultural Research Center, Hilo, HI
Roger I. Vargas, (808) 959–4329, rvargas@pbarc.ars.usda.gov

Environmentally friendly insecticides made from sugar esters could be on the market as early as the end of 2000.

AVA Chemical Ventures of Portsmouth, NH, and ARS recently applied for a patent on the sugar esters—the result of an ARS concept conceived some 10 years ago.

The compounds are lethal to mites and soft-bodied insects almost instantly after contact. But they do little harm to insect predators, are completely nontoxic to animals and people, and quickly degrade into harmless sugars and fatty acids in the environment.

Throughout 4 years of tests, the sugar esters have been at least as effective as conventional insecticides—and sometimes more so—against mites and aphids in apple orchards; psylla in pear orchards; whiteflies, thrips, and mites on vegetables; and whiteflies on cotton. Pear psylla have become resistant even to newer insecticides, and mites are developing resistance.

Like insecticidal soaps, sugar esters kill insects by either suffocating them or by dissolving the waxy coating that protects them from drying environments. Because of the way they work, insects are not expected to develop resistance any time soon. The drawbacks: The esters must come into contact with the insect to be effective, and they don't kill insect eggs.

Appalachian Fruit Research Station, Kearneysville, WV
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ARS research to determine a biocontrol match for mesquite in the United States has uncovered two insects that will help Australia stop the plant from spreading "down under."

In the American West, balanced mesquite populations fix soil nitrogen, look great in gardens, and provide honey bees with nectar. But an overabundance causes ranchers to lose an estimated $250 to $500 million worth of water and land resources every year.

A variety of natural controls keeps South America's 31 mesquite species largely in check. While searching for biocontrols that would be just as effective in the United States, researchers discovered some that would benefit other countries, including Australia. They found that two leaf-eating insects—the leaf-tier moth and the psyllid *Prosopidopsylla flava*—could control the spread of mesquite without harming the adult plants.

The leaf-tier moth was found to be safe and effective after a 15-month quarantine study conducted by Australia's Commonwealth Scientific and Industrial Research Organization and was released. The psyllid was released after it was also found to be safe and effective.

South American Biological Control Laboratory, Buenos Aires, Argentina
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An organic mulch made from a cover crop called hairy vetch thwarts hungry Colorado potato beetles in vegetable crops.

The hairy vetch impedes beetle movement, thereby lessening their damage.

This pest is notorious for its ability to develop resistance to insecticides, so biocontrol is a key option against the pest.

In the study, beetle establishment occurred at a lower rate on tomatoes transplanted into hairy vetch mulch than on those transplanted into black plastic mulch. Yield of staked fresh-market tomatoes grown in hairy vetch mulch was comparable to control plots treated with insecticides.

The Colorado potato beetle costs U.S. potato, tomato, and eggplant growers about $150 million annually in losses and insecticide-related costs.

Noninsecticidal methods of control could be useful components of an integrated pest management strategy if they can reduce pesticide inputs, thus slowing the rate at which resistance develops.

Insect Biocontrol Laboratory, Beltsville, MD
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A tiny Amazonian fly called *Thrypticus* that attacks waterhyacinth has for the first time been reared in large numbers.

This is a crucial step toward seeing if the flies are suitable to be imported and test-released against this aquatic weed in the United States.

Waterhyacinth mats infest ponds, lakes, and streams across the South and in California and Hawaii. The impacts: less drinking and irrigation water, blocked boat travel, clogged pumping stations, and damaged water quality. The mats also choke out other aquatic plants and can make a waterway uninhabitable for native fish and other animals.

Natural control is essential to the weed's long-term control; herbicides and mechanical removal can be costly and ineffective. *Thrypticus* could become the first new insect imported to fight waterhyacinth since the 1970s.

ARS researchers and colleagues discovered the new species in 1999 in the upper Amazon River basin. Immature *Thrypticus* flies feed within inflated stalks known as petioles that connect the leaves to the stems. The petiole is actually part of the leaf and may be up to 3 feet long and an inch thick or more. The flies' tunneling can let in microbes to further weaken or kill the plants.

In December 1999, ARS researchers in Argentina released hundreds of adult *Thrypticus* on waterhyacinth in an outdoor cage. The flies reproduced by the thousands.

Since 1996, the scientists have found 11 new South American species that attack water-hyacinth and its relatives.

These include six *Thrypticus*, three *Taosa* plant hoppers, and two *Megamelus* plant hoppers.

Researchers are screening them to identify the best biocontrol candidates. They are also making sure waterhyacinth is the only plant the insects damage.

South American Biological Control Laboratory, Buenos Aires, Argentina
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Plant Genetic Resources

Narrowleaf and big trefoil lines released by ARS scientists should give breeders new opportunities to improve forage for livestock and wildlife.

Trefoils offer advantages over alfalfa, because they don't cause bloating in the grazing animals and can grow in harsher conditions. As legumes, they also fix nitrogen into the soil—in other words, transform nitrogen from the atmosphere into forms that plants can use for growth. This can reduce the need for fertilizer and purchased feeds for livestock, lowering production costs.

Though birdsfoot trefoil has become popular, U.S. growers have not had much access to narrowleaf or big trefoil. The new releases—ARS–1207 narrowleaf trefoil and ARS–1221 big trefoil—combine the characteristics of dozens of different genetic populations collected from around the world. That way, breeders can use them to evaluate all available characteristics for each species without individually testing dozens of different plants.

Researchers and breeders can obtain small amounts of seed from Jeffrey Steiner.

Forage Seed and Cereal Research Unit, Corvallis, OR
Jeffrey Steiner, (541) 750–8734, steinerj@ucs.orst.edu
Plant Genetics Research Unit, Columbia, MO
Paul Beuselinck, (573) 882–6406, BeuselinckP@missouri.edu

Computer Systems and Models

The Revised Universal Soil Loss Equation (RUSLE) provides conservationists with a tried and tested method for selecting the best conservation plans for controlling soil erosion.

Soil erosion by water continues to be a major problem affecting croplands, rangelands, and forests, landfills, military training grounds, mined and reclaimed land, and construction sites.

In developing this erosion prediction technology, ARS scientists provided conservationists with a planning guide for selecting a land-use practice with a predicted soil loss that is lower than the acceptable limit.

This limit is usually referred to as the soil-loss-tolerance value.

The widely used RUSLE is considered to be the best erosion prediction technology available for conservation planning at the local field office level. As a consequence, RUSLE has been implemented by the USDA's Natural Resources Conservation Service throughout its field office system. It has been routinely used by local NRCS conservationists to help farmers and other land users protect and preserve the landscape and associated soils for years of future productive use.

This erosion prediction technology has also been used by many public and private organizations to assist in conservation planning so as to ensure that the land is used in ways that prevent excessive erosion, provide for the land's long-term maintenance as a natural resource, and protect downstream areas from excessive sedimentation and degradation of water quality.

National Sedimentation Laboratory, Oxford, MS
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To rehabilitate and revitalize thousands of U.S. earthen dams, scientists will need to rely on more than 60 years of ARS hydraulic engineering research, expertise, and databases.

Today, many of the dams no longer work efficiently and need repairs. Many of these 10,000 flood-control structures, constructed with the assistance of USDA, were designed with a 50-year service life. Unlike dams along rivers, these protect

the nation's watersheds. Many serve as municipal water supplies; prevent floods; provide water for irrigation, recreation, fish and wildlife habitats, and groundwater recharge; and improve water quality. Yearly, they provide Americans with more than $800 million in benefits.

Over the next 10 years, more than 1,000 earthen dams will need significant repairs and modification. ARS and USDA's Natural Resources Conservation Service are developing technologies for rehabilitating and revitalizing the dams, and software for applying the technologies to solve engineering problems.

The software program, called SITES, combines the principles of geology, hydrology, soil science, and physics to predict the performance of vegetated earth spillways used in these structures. It will be used to predict how an earthen spillway will perform and to evaluate its potential for failure.

Future versions will incorporate current research to predict the damage that results from embankment overtopping.

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Quarterly Report

of Selected Research Projects

USDA United States Department of Agriculture

ars Agricultural Research Service

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Contact the scientists listed for further information on each research project. For general questions about this report, contact Hank Becker, ARS Information, 5601 Sunnyside Avenue, Beltsville, MD 20705, (301) 504-1624, hbecker@asrr.arsusda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact ARS Office of Technology Transfer, 5601 Sunnyside Avenue, Beltsville, MD 20705-5131. Questions about a company's product and/or research should be directed to the company itself.

This publication is available on the World Wide Web at http://www.ars.usda.gov/is/

Into the Marketplace

ARS scientists have reformulated their reduced-sugar, low-fat milk shakes.

The new drinks are a remake of a previous ARS low-sugar variety developed in the 1970s for USDA's School Lunch Program. The new shakes have less than half the sugar and about 10 percent of the fat found in commercial shakes.

Last fall, ARS opened its doors to about 600 youngsters who taste-tested the chocolate shakes. Kids weren't crazy about them. Some comments: "Not sweet enough"; "There's an aftertaste;" and "Tastes like cereal."

As a result, ARS scientists, along with their cooperative research and development agreement partner Devine Foods, Inc., in Philadelphia, PA, are trying to reformulate the shakes, eliminate the cereal flavor, and further develop them as a commercial product.

The shakes are based on ARS technology and contain Devine's patented composition, which reduces fat and calories. Fiber content is about 2 to 2.2 percent, which qualifies the shakes as a good source of fiber. A 10-ounce shake has as much calcium, vitamins, and minerals as a serving of milk—with fewer calories. It also has significantly less lactose than milk.

Dairy Products Research Unit, Eastern Regional Research Center, Wyndmoor, PA
Richard Konstance, (215) 233-6600, rkonstance@arserrc.gov

Cooperative Research and Development Agreements

...With Durand-Wayland, Inc., LaGrange, GA, to develop special tree sprayers to manage trunk-feeding insects of peach and other stone fruits.

Peach tree pests, such as the peach tree borer and white peach scale, are hard to manage using typical spray methods. Estimates of losses and control costs for these two pests during 1997 for Georgia alone were $1.44 million. Both insects feed on tree trunks.

Growers currently use hand-held spray guns to apply insecticides, which are effective but require three workers to spray an entire orchard (one driver and two spray-gun operators). Spray coverage can become inconsistent over time as workers tire.

The new sprayer the partners will develop will incorporate site-specific applications that can be turned on and off on demand. This should result in better insect control with less insecticide use and an economic savings to growers.

Southeastern Fruit and Tree Nut Research Laboratory, Byron, GA
Ted E. Cottrell, (912) 956-6448, tcottrell@byronresearch.net

...With Loders-Croklaan Co., Channahon, IL, to develop commercial uses for various forms of linoleic acid, an essential fatty acid.

Linoleic acid is one of a small group of uniquely important

fatty acids that cannot be made in the body, so it must be consumed in the diet. Important in maintaining cell membranes, it also plays an important role in preventing blood clots.

Recent research has shown that some forms of linoleic acid may offer additional health benefits. Separating key components from more than 30 different forms of linoleic acid will allow the researchers to identify the role of each one and its effects on human health.

Methods to separate fatty acids already exist, but they work only on small amounts. The ability to separate linoleic acids in large quantities will allow researchers to conduct extensive studies on the compounds. Knowledge gained through investigating the medical and nutritional roles of isolated pure fatty acids could lead to new dietary approaches or food products to optimize human health and nutrition.

Eastern Regional Research Center, Wyndmoor, PA
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...With Mycotech Corp., Butte, MT, to study a unique relationship between the parasitic fungus *Beauveria bassiana* and corn.

B. bassiana kills the European corn borer, a primary insect pest throughout major U.S. corn-growing areas. The fungus occurs naturally in corn and has been isolated from plants throughout the Corn Belt. In 1997, the occurrence of the fungus ranged from a low of 6 percent in Michigan to a high of 91 percent in Illinois.

Extensive field research determined the ideal time to apply *B. bassiana* for the fungus to live and grow.

When applied to the whorl—that part of the corn plant where the leaves unfurl to form a natural funnel—*B. bassiana* germinates and enters the plant through leaf tissue.

Once inside, it kills any corn borers that enter. However, neither coating seeds with *B. bassiana* nor placing it in the seed furrow at planting time increased its growth in the corn plants.

Five potential carriers—corn kernel, corn cob grit, clay, and two starch substrates—were evaluated in granule formulations of *B. bassiana*.

They all reduced insect damage and protected grain yield equally well.

Data from this CRADA enabled pest management specialists to develop protocols for using *B. bassiana* in a borer management program.

Corn Insects and Crop Genetics Research, Ames, IA
Leslie C. Lewis, (515) 294-8614, leslewis@iastate.edu

...With DEC International, Lodi, WI, to adapt ARS-patented Vacuum Steam Vacuum (VSV) "Flash" pasteurization technology for processed meats.

All foods have a layer of air around them that slows down the process for using steam to kill bacteria on foods. The VSV technology removes this air layer, kills the bacteria with steam, and then evaporatively cools the meat. It's done in a "flash," taking less than a second to perform.

Cooling the meat after steaming is especially important for processed chickens to prevent immediate cooking. Also, a major concern for industry is preventing foodborne pathogens from contaminating ready-to-eat meats like hot dogs once they have been cooked at the processing plant. *Listeria monocytogenes* has been a bacterial culprit in many ready-to-eat food contaminations. There is a zero-tolerance for this bacterial pathogen, since it can grow and spread in cold storage.

ARS researchers conducted preliminary studies using VSV to treat hot dogs and achieved up to a 99.999-percent kill rate against *L. monocytogenes*. According to the Centers for Disease Control and Prevention, about 1,600 cases and 415 deaths occur annually in the United States from listeriosis caused by ready-to-eat meats contaminated with Listeria.

Listeriosis produces flulike symptoms, such as fever and chills. The CRADA collaborators are hoping to develop a unit to treat hot dogs that will meet federally mandated Hazard Analysis and Critical Control Points (HAACP) standards.

HAACP requires the food industry to identify and correct potentially hazardous points in their production lines that may cause bacterial contamination.

Eastern Regional Research Center, Wyndmoor, PA
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...With Deere and Company, Conyers, GA, to evaluate the concept of site-specific tillage and to develop specialized equipment for that purpose.

This technology should allow farmers to save 25 to 75 percent on tillage energy costs. That's because farmers often till compacted soil deeper than necessary. Currently, farmers manu-

ally set the tillage depth and maintain it throughout the field. This depth is usually based on the maximum needed for the most compacted areas.

Deeper-than-necessary tilling is a problem because it can bury excessive amounts of plant residue, increasing erosion and carbon emissions and possibly decreasing crop yields.

ARS researchers and their partners plan to conduct experiments to determine the economic benefits of precisely pinpointing compacted areas of Coastal Plain-type soils that are prevalent in the southeastern United States.

Then they'll remedy compaction with targeted depths of tillage using global positioning systems to maintain locations within the fields.

This research will help farmers develop economical and environmentally friendly methods for reducing excess soil compaction.

National Soil Dynamics Laboratory, Auburn, AL
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Patents

...For a new ARS-developed method for enzyme recycling that could amplify current uses of domestic animal fats and vegetable oils, as well as products derived from them.

Enzymes are complex proteins that are nature's way of "making things happen" when it comes to carrying out specific chemical reactions in plants and animals.

Manufacturers rely on imported castor oil for making certain commercial materials. Castor oil is imported from South America, China, and India. Using the ARS technology, it is now possible to produce castor-oil-type fatty acids from domestic fats and oils, instead of relying on imports.

Enzymes used in this way are more stable and can be used repeatedly, which is more economical. Current processes rely on nonreusable enzymes that make the process more expensive.

This technology allows manufacturers to improve the properties of domestic fats and oils for use in applications such as lubricants, greases, emulsifiers, and plasticizers. ARS scientists have expanded this research to include other enzymes, which are being used to convert oils, fats, and restaurant greases into biodiesel fuels and lubricants.

Biodiesel products are a renewable alternative to petroleum-derived diesel fuels. ARS researchers are looking for industrial partners to develop this technology commercially. (Patent Application No. 09-239,778)

Eastern Regional Research Center, Wyndmoor, PA
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Licenses

...To EcoSoil Systems, Inc., San Diego, CA, to develop disease-fighting seed and foliar treatments based on ARS technology.

Root diseases cost U.S. wheat and barley growers millions of dollars each year in reduced yields. ARS scientists found premier strains of bacteria in nature that inhibit some of the worst root diseases: take-all, Rhizoctonia root rot, and Pythium root rot.

When used as a seed treatment, these bacteria control disease with 100 times fewer bacteria per seed than normally used. These natural strains of *Pseudomonas* bacteria already live in the soil; they reproduce very quickly and outcompete other soil microbes for nutrients. The bacteria naturally produce compounds that inhibit disease-causing fungi.

ARS has applied for a patent on the premier strains and the techniques used to discover them. Ecosoil Systems will develop treatments such as seed coatings, using the bacterial strains to protect crop plants.

Researchers have found that similar high-powered strains are present in many soils and could provide biological alternatives for control of many crop diseases.

They've also developed techniques to enhance the natural disease-fighting ability of the bacteria. By introducing genes from related *Pseudomonas* strains that produce other antifungal metabolites into the premier strains, they can get more effective premier strains that control all three diseases. These strains fight disease at even lower numbers of bacteria per seed.
(Patent Application Nos. 08/974,938; 08/994,035)

Root Disease and Biological Control Research Unit, Pullman, WA
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Soil, Water, and Air Quality

A first-of-its-kind study of the transport and fate of two pesticides in vegetated agricultural drainage ditches suggests that ditches are valuable tools for reducing chemical runoff.

Most agricultural fields are surrounded by drainage ditches that carry runoff water from fields following storms or controlled releases, as from rice fields. ARS scientists simulated a storm runoff event on the Beasley watershed—one of three Mississippi lakes in the Mississippi Delta Management Systems Evaluation Area (MSEA).

The MSEA project is a national effort by the U.S. Department of Agriculture to protect farmland watersheds. It is designed to develop and test farming methods that will work with nature, instead of damaging water quality.

The scientists calculated the percentage of runoff that a ditch may be exposed to during a small storm. Their goal: to pinpoint the ditch's role in keeping irrigation water and pesticides from entering water bodies. They found that ditches trapped 60 to 90 percent of the atrazine and a commonly used insecticide, Karate, associated with the runoff.

Farmers want methods to decrease the amount of potentially harmful pesticides, nutrients, and sediments leaving their fields.

Ditches, through their soil and vegetation, can sequester these runoff materials, thereby decreasing potential harm to downstream lakes, rivers, and streams.

National Sedimentation Laboratory, Oxford, MS
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Switching dairy cows from alfalfa to red clover silage will reduce manure nitrogen levels, a boon for the environment.

That's because red clover has an enzyme—polyphenol oxidase—that reduces protein breakdown in the silo. With alfalfa, usually more than half of the protein is broken down in the silo; this results in reduced protein efficiency in the cow, according to ARS dairy scientists.

In recent trials, cows fed red clover silage produced the same amount of milk as cows fed alfalfa silage, and they did so on less feed. Protein efficiency was 17 percent better on red clover than alfalfa.

If this improvement applied to only the first half of lactation, when cows are fed the most protein, nitrogen excretion would be reduced by about 1.5 tons per year on a 100-cow dairy farm.

Red clover grows better than alfalfa in the acidic soils common in the Midwest. Other pluses: Red clover seed is cheaper for producers than alfalfa seed, and red clover will be easier to grow—thanks to improved resistance and persistence of new varieties developed by an ARS plant breeder.

ARS will release these newer varieties in the fall of 2000. Seed will be available to farmers in about 2 years.

U.S. Dairy Forage Research Center, Madison, WI
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Can a change in farming practices help reduce car accidents?

Each year, several serious multicar accidents are caused by high winds' blowing topsoil across highways. Standing crop residue can be 10 times more effective than flat residue in reducing wind erosion in erosion-prone areas of the West, Midwest, and Northern and Southern Plains.

Erosion causes the loss of more than 2 billion tons of soil from U.S. cropland each year. Wind erosion accounts for 45 percent of this loss.

To guard against erosion, ARS scientists designed a lightweight, portable scanner that can be used by farmers, crop consultants, and USDA Natural Resources Conservation Service employees to measure standing crop residue.

Old ways of measuring standing crop residue were tedious and labor intensive. The standing residue scanner was modeled after a laser surface scanner developed by ARS soil scientists at the National Soil Erosion Research Laboratory in W. Lafayette, IN.

Today, the original surface scanner is used around the world by soil scientists in Australia, Austria, China, and Germany.

Recent improvements in the design have resulted in a new surface scanner that is 100 times faster than the original.

Wind Erosion Research Unit, Manhattan, KS
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Soaking willow cuttings in water for 10 days before planting doubled their survival rate along stream channel banks.

Channel erosion is a serious problem in many areas. For years, researchers have tried to stabilize streambanks with planted vegetation. This can be cheaper than artificial structures and offers much environmental benefit. But success rates have varied widely, and few scientific studies have been done to find out why.

ARS researchers working with scientists at the University of Memphis have focused on using large-diameter cuttings of native black willow. To find ways to enhance willow survival, the scientists ran a series of field and greenhouse studies which showed that cuttings are very sensitive to the amount of moisture and sandiness of the underground environment.

To improve survival rates, the scientists tried soaking some cuttings in water for 3 or 10 days before planting them; some weren't soaked at all.

Those soaked for 10 days far outperformed the others, showing better growth, biomass production, number of roots, and other benefits. This finding will be of great interest to all who are working to restore the nation's degraded streams.

National Sedimentation Laboratory, Oxford, MS
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Farmers may have an answer to their questions about varying crop yields within a field.

Using satellite global positioning systems and combine monitors, scientists and farmers have documented this variability of yields. They want to determine what combination of soil, weather, and management factors is causing it. This information should increase yields and reduce costly chemical inputs, which in turn would lower the risk of contaminating water resources.

ARS researchers working with Iowa State University-Ames scientists have found that higher yields may be influenced partly by management practices and topography at the lowest field elevations, while lower yields seem linked to soil types and topography.

They measured the yield variability of corn and soybeans within a 50-acre farm field and related it to soil properties—in particular, the Soil Tilth Index. Developed at the National Soil Tilth Laboratory, this index of soil health ranks the soil's suitability as a seedbed, which is an accurate predictor of crop yield variation. The index accurately predicted corn and soybean yield, but only for part of the field. Factors other than tilth determined crop yield for the remainder.

National Soil Tilth Laboratory, Ames, IA
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ARS scientists are pioneering new efforts in "green technology," using plants to clean up soils contaminated with heavy toxic metals.

Contaminated soils and waters pose major environmental, agricultural, and human health problems worldwide. These problems may be partially solved by a new technology called phytoremediation. It uses green plants to remove pollutants from the environment or render them harmless.

Current engineering-based technologies used to clean up these soils—like removing contaminated topsoil for storage in landfills—are very costly and dramatically disturb the landscape. But green technology uses certain plant species, known as metal hyperaccumulators, to "vacuum up" heavy metals from the soil through their roots and store them in aboveground plant tissue.

Once extracted from soil and concentrated in the easily harvested plant stems and leaves, these elements can be collected, reduced in volume, and stored for later use. Scientists are studying plants like *Thlaspi caerulescens*, which thrives on soils contaminated with high levels of zinc and cadmium, and *Amaranthus retroflexus*, which removes up to 40 times more radiocesium from soil than other plant species tested.

Plant, Soil, and Nutrition Laboratory, Ithaca, NY
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Food Safety and Quality

Lactic acid, commonly used in foods as a flavoring or preservative, can help reduce salmonella in two important organs of broiler chickens.

One organ—the crop—is part of the chicken's esophagus. The other organ—the ceca—is a blind pouch connected to the large intestine. Both organs are prone to bacterial contamination.

ARS researchers added two tablespoons of lactic acid to 1.2 gallons of drinking water for pre-slaughter broiler chickens. Salmonella microbes were reduced by 41.5 percent in the crop and by 11.2 percent in the ceca.

Poultry carcasses may become contaminated if these organs are ruptured during processing. If Salmonella is present, the highest concentration of bacteria is found in the ceca. But the bacteria in the birds' crops are also significant, because the crop ruptures 86 times more often than the ceca in the processing plant.

Lactic acid acidifies the content of these organs, making them less conducive to bacterial growth. Using food-grade lactic acid, the researchers estimate the cost is about 0.2 cent per bird.

Food Safety Research Unit, College Station, TX
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By knocking out certain Salmonella genes, ARS food safety researchers may discover genes are crucial to this microbe's ability to attack foods.

The research, which is being conducted with the sprouted seeds of broccoli, radish, alfalfa, and mung bean, could lead to new and more effective tactics to thwart Salmonella not only in sprouts, but in other fresh produce—and perhaps even in meats and poultry—as well.

The ARS investigation into the key Salmonella genes may be unique. So far, the experiments in which a gene or genes have been knocked out of lab strains of the pathogen have yielded a Salmonella that is only one-tenth as effective in colonizing fresh sprouts.

Now scientists need to determine which of the 4,000 to 5,000 Salmonella genes are missing or disabled in that strain. The researchers expect that help in answering this question will come from scientists elsewhere who are collaborating in an international effort to determine the makeup and function of all Salmonella genes.

Besides adding color, taste, and texture to salads, sandwiches, soups, and other dishes, sprouts provide protein, fiber, and antioxidants such as vitamin C.

Food Safety and Health Research Unit, Albany, CA
Amy O. Charkowski, (510) 559-5647, amy@pw.usda.gov

Animal Production and Protection

Horse owners who transport their animals internationally for equestrian competitions may soon have an easier time ensuring their horses are healthy, thanks to new ARS-developed tests for piroplasmosis.

The United States is free of this tickborne disease, also known as equine babesiosis. To keep the disease from infecting American animals, horses coming here for races, shows, and other competitions must be certified free of the disease.

That can be costly, because horses must be quarantined while they are awaiting test results and often must be retested to ensure accurate results. In addition, American horses traveling to other countries that have piroplasmosis must be tested before they can return.

The new tests—one for each of the two parasites that can cause the disease—should speed up the process once they are accepted as appropriate by international regulatory authorities. The current test, called a complement fixation test, can give false positive or false negative readings. The new tests rely on molecular techniques that give more accurate results.

Another advantage: The new tests do not require the use of live horses. Genetic material used in the new tests can be grown in bacteria. The complement fixation test relies on obtaining parasites and blood with antibodies from infected animals.

ARS and Washington State University collaborators have

applied for patents. VMRD, a Washington company that produces diagnostic test kits, plans to sell the tests under a patent license within the next 5 years.

Animal Disease Research Unit, Pullman, WA
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By scrutinizing the chromosomes that store cow DNA, ARS animal scientists are helping lay the groundwork for a genetic roadmap of the animal's traits.

It may be years before such a map is finished, but some short-term spinoffs are emerging. One possibility is a genetic test to predict the degree to which newborn calves will express traits inherited from a prized bull.

It now takes 5 years before a dairy calf's traits can be fully evaluated.

However, using specific stretches of DNA chemicals called nucleotides as markers, scientists envision tests for making such predictions much sooner—either from a few embryonic cell samples, or from a blood sample from a newborn calf.

In genetic mapping studies, scientists use the markers to locate DNA regions where important genes are found. On chromosome 27, for example, they've identified potential markers for "dairy form," a trait for the ideal physique in cows.

Another marker, on chromosome 23, may point to genes' influencing a cow's response to mastitis, an udder disease that costs the dairy industry $1 billion annually in losses. Also of interest are markers for unknown genes that will lead to enriched dairy products and improved cheesemaking.

Gene Evaluation and Mapping Research Laboratory, Beltsville, MD
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GT-HID9, a new germplasm source of yellow dent maize, could mean good news for Southeastern dairy farmers in the form of new commercial hybrids.

ARS and University of Georgia researchers released the maize germplasm to plant breeders for two key traits: adaptability to the Coastal Plain's sandy/loam soils and warm southern climate, and suitability as corn silage that milking cows can readily digest.

Currently, few such hybrids are available to dairy farmers in Southeastern States like Georgia, where 95 percent of the Coastal Plain's corn crop is grown.

Now, with the release of GT-HID9 seed to plant breeders, new silage hybrids may become commercially available within 6 years.

GT-HID9 is the product of nearly 10 years of work involving a technique called restricted recurrent phenotypic selection.

From an older hybrid, Coker 77B, researchers propagated and screened thousands of plants for silage/forage traits with high dry-matter digestibility. With the help of *in vitro* studies using cow rumen, they zeroed in on GT-HID9, a plant population whose digestibility ranking exceeds Coker 77B's by more than 1 percent.

In the cow's rumen, where a microbial slurry digests fiber, this seemingly low percentage actually means significant increases in absorption and use of nutrients from silage for producing milk.

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Beekeepers who want to replace aggressive, defensive African queens with gentle, easily managed European ones may face a little-known disadvantage, an ARS scientist and University of North Carolina co-researcher have discovered.

Within only 1 week after their queen dies or is removed by beekeepers, Africanized worker bees—which are female—can produce their own viable eggs for requeening the hive.

That gives the Africanized bees a headstart in the battle for hive rule, because European worker bees' ovaries can't start producing eggs until the queen has been missing for at least 3 weeks.

Queenless Africanized workers that have developed ovaries and are laying their own eggs are less likely to accept a new European queen—and may attack and kill her. New experiments, however, may yield tactics to undermine the Africanized bees' competitive advantage.

The 1-week time frame was already known to occur in Cape bees of South Africa, but it had not—until now—been reported for Africanized hives in the Northern Hemisphere. Africanized bees, which sting

more readily then their European counterparts, have invaded Arizona, California, Texas, New Mexico, and Nevada.

ARS Carl Hayden Bee Research Center, Tucson, AZ
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Canola grown on soils high in selenium or irrigated with water that's overloaded with this mineral may boost the health of livestock—and the environment.

Animals and people require small quantities of selenium to stay healthy. But in high amounts, it can become a toxic contaminant of soil and water. With further testing, canola plants used to remove excess selenium from soil or water might then be fed to farm animals to ensure they get enough of this essential nutrient.

Right now, selenium deficiency is a major problem for livestock or wildlife in at least 37 states and costs beef, dairy, sheep, and horse producers an estimated $545 million in losses every year.

Ranchers in regions where soil is low in selenium either inject their livestock with the mineral or provide selenium supplements to the animals.

In a preliminary study, ARS scientists fed selenium-enriched canola hay to lambs and dairy cattle, then monitored levels in the blood, milk and other samples.

The researchers used canola that irrigated with high-selenium drainage water. Selenium content of the canola didn't exceed a safe level—the equivalent of about a pinch of selenium per bale of hay, or 5 milligrams per kilogram of dry matter.

All of the animals remained healthy throughout the study. The experiment was likely the first to use—as an animal feed or supplement—canola that had been grown to remove selenium from soil.

Follow-up tests may determine whether this approach to enhancing the selenium content of livestock feed is a safe way to forestall selenium deficiency.

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New strides in ascites research could help prevent this fatal heart condition in chickens.

Ascites can cost U.S. poultry producers $100 million a year.

When a chicken gets it, the right ventricle of its heart enlarges and can't pump blood efficiently, eventually leading to death. It takes just 6 weeks for birds to grow large enough to go to market, and their hearts and lungs have to work hard to accommodate this rapid growth pace. Some birds' bodies can't keep up, leading to ascites. Often, birds raised at high altitudes develop this condition.

ARS researchers used a special chamber to simulate higher altitudes and the occurrence of ascites. They then identified and selectively bred ascites-resistant and ascites-susceptible birds. In the fourth year of the study, ARS and University of Arkansas scientists have selected over four generations for broilers that are resistant or highly susceptible to this disease.

The resistant population exhibits no more than 20 percent ascites at simulated high altitudes, while the susceptible line has greater than 80 percent.

To control ascites, producers now restrict feed, which slows down birds' growth and reduces mortality. But these birds take longer to reach market weight and can have less white meat, the most valuable part of the chicken.

ARS researchers suggest that poultry producers maintain optimal temperatures or increase ventilation in their poultry houses to improve air quality and reduce the incidence of ascites.

Poultry Production and Product Safety Research Unit, Fayetteville, AR
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ARS scientists have found more than 340 different chemical scents produced by human skin, some of which are attractive to mosquitoes.

In laboratory tests, about 90 percent of the mosquitoes come to one particularly alluring mixture. This is impressive, considering a human arm and hand attract about 70 percent of the same species of mosquitoes.

The researchers developed a technique using tiny glass beads that adsorb some scents to help identify mosquito-attractive organic compounds from humans.

Finding the right chemical scent is important, because what may be attractive for one species may not be for another.

Out of 2,700 mosquito species worldwide, four to six dozen transmit diseases, making it difficult to pinpoint attractants unique to each.

Ultimately, a better understanding of mosquito attraction should help in developing more effective, environmentally safe repellents for protection from insects that prey on humans and livestock.

Center for Medical, Agricultural, and Veterinary Entomology, Gainesville, FL
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ARS scientists are closing in on a vaccine that protects fish from a *Streptococcus* bacterium. ARS is cooperating with scientists of Intervet, Millsboro, DE, to further develop and field test this vaccine under a cooperative research and development agreement.

S. iniae is an emerging bacterial pathogen in cultivated tilapia, hybrid striped bass, rainbow trout, yellowtail, eel, and turbot. Worldwide, streptococcal infections are reported in 22 species, both cultured and wild.

S. iniae is recognized as one of the most problematic bacterial pathogens in intensively cultured tilapia and hybrid striped bass in the United States. The combination of good health management practices and vaccination is a superior approach to the use of antibiotics or chemicals. Antibiotics are currently used to control the streptococcal disease, which causes $150 million a year in losses worldwide.

The *Streptococcus* bacterium possibly enters the noses of hybrid striped bass and tilapia from the water. The higher the density of cultured fish, the more easily *Streptococcus* is transmitted and the higher the mortality rate.

Signs of the disease in fish are abnormal behavior like erratic swimming, whirling motion at the surface of the water, darkening of the skin, blindness, popeyes, and small lesions on the body, fins, and anus.

ARS scientists are also researching fish behavior and health problems related to fungal, algal, bacterial, and chemical toxins implicated in fish kills in U.S. coastal waters.

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Human Nutrition

Tiny, premature infants did just fine when given an intravenous feeding containing far less glucose than the amount usually given.

Researchers found that the 5-day-old preemies were able to make their own glucose using amino acids and fats added to the feeding solution as glucose replacements.

This means the amount of glucose in the intravenous solution could safely be reduced, which would cut the risk of high blood glucose levels without increasing the risk of glucose levels that were too low.

Healthy, full-term babies are able to break down their glycogen, fat, and protein stores to make glucose. But very premature infants are born before these stores develop. So they are given extra glucose to prevent a brain-damaging drop in their blood glucose levels and to meet their energy needs. That often produces high blood sugar, however.

When this happens, they lose precious sugar, water, and salts through the urine, putting them at risk for dehydration and electrolyte imbalances. Excess glucose can also affect the amount of carbon dioxide these infants produce, exacerbating problems for those with lung disorders.

To test metabolic capacity, researchers cut the glucose infusion rate by 75 percent in 20 very premature infants, while providing amino acids and a fat emulsion. Despite this reduction, blood glucose levels remained in the normal range for all infants throughout the 8- to 12-hour study period.

Tracers showed that the majority of the glucose the infants produced was derived from the fat and amino acids in the intravenous solution, confirming that they could use their own metabolic pathway to make glucose when needed.

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Crop Productivity

The release of new upland cotton germplasm should provide valuable sources of genes to enhance traits of economic importance to the cottonseed and textile industries.

The lines originated as 58 randomly selected plants from crossing PD-3-14 germplasm, released by ARS in 1993, and Simian 2, developed by the People's Republic of China's Cotton Research Institute at the Chinese Academy of Agricultural Sciences in Anyang, Henan Province. They have been maintained under forced self-pollination to control genetic variance. The lines also have been evaluated for an array of agronomic and fiber traits.

Compared with their parents, the 58 lines vary widely in lint yield, lint fraction, boll size, seed index, weight of lint per seed, fiber property strength, length distributions, fineness, short-fiber content, maturity, and immature fiber content. Encoded genes for these traits can be tagged with molecular markers for breeding, and functional genomic analysis can be used to discover new genes.

A limited quantity of seed is available from ARS for distribution to cotton breeders and geneticists. Genetic material will be deposited in the National Plant Germplasm System, where it will be available for research, including development and commercial sale of new cultivars.

Coastal Plains Soil, Water, and Plant Research Center, Florence, SC
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A native bee that excels in pollinating blueberries is—surprisingly—befuddled by the task of pollinating a blueberry relative, the American cranberry.

Osmia ribifloris, a medium-sized bee that sometimes has emerald-green highlights in its shiny, steel-blue body, is seemingly an ideal candidate for work in cranberry bogs. That's because blueberries and cranberries—both native to the United States—are cousins.

But ARS tests using *O. ribifloris* bees in screen cages placed over blooming cranberry plants in a commercial New Jersey bog showed that the native bee consistently lands in the wrong position on cranberry flowers.

That means the bee isn't able to use its legs to hit, or drum, the flowers' pollen sacs. Normally, drumming would cause the sacs to release pollen that would then be trapped in the dense brush of short hairs on the female bee's abdomen.

Scientists have eliminated *O. ribifloris* from the list of potential cranberry pollinators and are focusing their efforts on two other promising candidates that they observed landing correctly on the blooms. Those bees are an *O. ribifloris* relative called *Osmia atriventris* and an energetic leaf-cutting bee called *Megachile addenda*.

Cranberry growers funded the research through a cooperative research and development agreement. They are seeking new pollinators to help out *Apis mellifera* honey bees beleaguered by competition from aggressive Africanized honey bees or by attack by tracheal and varroa mites, small hive beetles, or microbes that cause chalkbrood, American foulbrood, and other diseases.

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Compounds called peptides that may play important roles in controlling feeding and reproduction have been detected in extracts from an important soybean pest.

Soybean growers currently use resistant bean varieties and crop rotation to battle their greatest foe, the soybean cyst nematode. This microscopic, wormlike parasite costs growers about $1.5 billion annually.

But resistant soybean varieties are not effective against all races of the nematode and usually have lower yields than susceptible varieties when nematodes are absent. The discovery of these peptides in parasite extracts opens a new path for scientists investigating naturally based controls for soybean cyst nematodes. The key may be the peptides' potential involvement in regulating nerve transmission and muscle activity, as well as feeding and movement, in these pests.

At least three different peptides have been observed in the nematodes grown on soybean plants.

The peptides in soybean cyst nematodes differ from those in nonparasitic species, and their levels vary during the worms' development. Researchers are focusing on those which would be most active in female nematodes, since they will lay the eggs that yield new generations of hungry, root-eating offspring.

Nematology Laboratory, Beltsville, MD
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A 4-year study of weeds in central Iowa shows that success of integrated weed management relies on matching control strategies to the specific weed problem.

In field tests, ARS scientists studied the emergence characteristics and seed persistence of four important weed species—common waterhemp, giant foxtail, woolly cupgrass, and velvetleaf.

First-year emergence ranged from 5 to 40 percent for woolly cupgrass, giant foxtail, velvetleaf, and common waterhemp, in that order. There were no differences in emergence during the second and third years. Velvetleaf and common waterhemp seedlings continued to emerge during the fourth. But a greater percentage of common waterhemp seed persisted each year, with 12 percent of the original seed recovered after 4 years of burial, compared to 5 percent of velvetleaf seed.

These findings are valuable to crop consultants and farmers as they evaluate weed problems and plan control programs.

In addition, weed emergence was consistent over the varying environmental conditions that occurred during the research. This consistency supports the potential to develop tools to predict weed emergence over broad geographic areas. Such tools would improve weed control and reduce herbicide use by improving the timing and efficiency of field operations like scouting, tillage, and herbicide application.

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Rice production may contribute to global warming by increasing methane emissions. But periodically draining the acreage in rice crops drastically decreases these emissions.

Methane is a greenhouse-effect gas that has a 20-fold greater global warming potential than carbon dioxide (CO_2).

Rice grows best in wet soil with its roots flooded. But flooded rice crops emit substantial amounts of methane into the atmosphere—especially when fresh organic matter, like plant residues, is added to the soil.
ARS researchers found that draining the soil for two or three short periods during the growing season to aerate the crop's roots may be an easy, environmentally friendly, on-farm practice that would help decrease methane emissions.

The researchers also indicate that drainage and nitrogen fertilization need to be coordinated to minimize nitrous oxide emissions after reflooding the soil.

Current world rice production is 384 million tons. Rice is the primary food for about 50 percent of the world's population.

Other studies have shown that up to 20 percent of global methane emissions worldwide come from flooded rice fields.

Crop Genetics and Environmental Research Unit, Gainesville, FL
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California rice growers can reduce threats to their crop yield from excess salinity, based on guidelines developed by scientists with ARS and the University of California Cooperative Extension Service.

In California, rice is grown in flooded fields throughout a series of adjacent basins. California ranks third in U.S. rice production, behind Arkansas and Louisiana. In 1999, more than one-half million acres were harvested in the state.

State regulations require that water be held in these basins for a certain period of time to allow pesticides used by rice farmers to degrade before the water is released into local waterways. In drought years, if the water is held too long, evaporation can concentrate salts to a level detrimental to plant growth.

International guidelines developed in the 1960s use an electrical conductivity value of almost 2,000 milligrams of salt per liter of water as the threshold for salinity concerns. But for rice growers under California climate and cropping conditions, researchers showed that yield losses started to occur when levels reached about 1,300 milligrams of salt per liter of water. At certain growth stages, damage resulted from even lower salinity levels.

Using guidelines developed with the researchers, regulatory agencies approved procedures for allowing emergency releases of the water if salinity levels increased to dangerous levels.

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Industrial (Nonfood) Products

An unusual, white-flowered kenaf plant appears highly resistant to powdery mildew, a costly disease that can attack kenaf leaves and seed pods in fall.

Caused by a microbe known as *Leveillula taurica*, powdery mildew can lower the quality and quantity of commercial kenaf seed harvests.

A fast-growing, bamboo-like relative of okra and cotton, kenaf makes a bright, high-quality paper that resists yellowing.

Kenaf can also be processed into acoustic tile, cat litter, bedding for horses and other animals, composite board for construction, mats for erosion control and grass seeding, and pads for cleaning up chemical or oil spills.

ARS scientists first noticed the unique kenaf in a plant nursery in Mexico, then tested it in the United States in field and greenhouse experiments.

Unlike commercial kenaf varieties, which produce yellow flowers, the experimental line—designated PVWF-90—bears smaller, white blooms. Because the white-flower characteristic is inherited and distinctive, this feature may prove to be an easily detected genetic marker of powdery mildew resistance.

That could simplify breeding of new commercial lines of kenaf that boast this valuable trait.

Besides providing the raw material for a variety of products, kenaf plants might also prove useful in cleaning up soil or water—a process known as phytoremediation. To determine whether kenaf could, for example, remove excess selenium from soils irrigated with selenium-rich water, ARS researchers and their colleagues in USDA's Natural Resources Conservation Service conducted a phytoremediation experiment with 120,000 kenaf plants. They grew the plants at a 1-acre site in central California. The hardy, deep-rooting kenaf plants shot up nearly 15 feet in only 6 months and removed about 25 percent of the soluble selenium that had accumulated in the first 3 feet of soil.

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Crop Diseases and Pests

When sterile Mediterranean fruit flies are recruited to keep their wild, fertile counterparts from getting established in warm weather states like California and Florida, a special strain of sterile medflies called Toliman TSLs may be the best for this important assignment.

Six years of tests by USDA scientists and their colleagues in the lush coffee plantations of southwestern Guatemala have shown for the first time that Toliman TSL sterile medflies may be anywhere from three to five times more effective than conventional strains of sterile medflies.

When invading medflies are detected on the mainland United States, sterile male medflies—mass-reared by the millions—are dropped from airplanes to find and mate with wild females. Because no offspring result, the population dies out. Medfly, or *Ceratitis capitata*, can infest more than 250 different kinds of fruits, vegetables, and nuts, and easily cost millions of dollars to eradicate.

Toliman TSLs are temperature-sensitive, lethal medflies, meaning that high temperatures can be lethal to eggs containing TSL females. The TSL trait allows mass-rearing of medflies that are exclusively males, thus saving the cost of producing unneeded females.

Also, not having sterile females to distract them once they are outdoors and looking for wild, fertile females may be a key to the TSL males' success. Insectary workers produce TSL males by bathing medfly eggs in 97 degree F water for 12 to 24 hours. That kills all of the eggs with female embryos inside but doesn't harm the males. Mass-rearing facilities in Hawaii and Guatemala that produce sterile male medflies for use in the mainland United States plan to begin producing TSL steriles exclusively.

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Application costs for boll weevil eradication could be reduced by adding refined cottonseed oil to malathion sprays.

The boll weevil, a cotton pest, has caused billions of dollars in damage, crop losses, and control costs since entering the United States in the late 19th century. For this reason, USDA started the Boll Weevil Eradication Program in 1978 to help farmers battle this pest.

The first year of the program begins in a particular area in August and continues into October. During this time, growers spray 8 to 12 applications of malathion to reduce the number of weevils entering diapause—the dormant period in their life cycle.

The researchers found that, during July, boll weevil mortality from an 8-ounce mixture of malathion and cottonseed oil was the same as from a 10-ounce application of undiluted malathion for the first 2 days after application. In August, however, there were no differences in mortality until 5 days after application.

The research also showed that malathion accumulates on the surface of mature cotton plants after repeated application during rain-free periods in August, implying that the interval between applications could be increased during this part of the growing season, thus reducing the number of applications and eradication costs.

The 8-ounce mixture of malathion/cottonseed oil is cheaper by 20 cents per acre per application than a 10-ounce application of malathion—a substantial cost reduction.

Application and Production Technology Research Unit, Stoneville, MS
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Forensic plant pathologists investigating the fungus that caused the Irish potato blight are using biotechnology to aid in their sleuthing.

In 1845, a fungus called *Phytophthora infestans* devastated the Irish potato crop. The population of Ireland was almost halved—from 8.2 million to 4.4 million—because of disease, starvation, and emigration. Hundreds of thousands of people emigrated to America.

Now, researchers at ARS and North Carolina State University at Raleigh are examining the past to find clues about the fungus' future. They have studied DNA from more than 66 herbarium samples of potato and tomato lesions to uncover information about the sexual state of the fungus.

Looking for the fungus' fingerprints, the scientists developed PCR primers to amplify DNA from the samples. So far, 20 of the samples have tested positive for the fungus, including an Irish specimen collected in 1846, British samples collected in 1845, 1846, and 1847, and samples from the USDA-ARS National Fungus Collection.

New England Plant, Soil, and Water Laboratory, Orono, ME
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Chemical cues in the saliva of tobacco budworm and corn earworm caterpillars cause plants to send out defensive signals when the caterpillars chew on them.

Small wasps, natural enemies of the caterpillars, then follow the defensive signals to find and sting the caterpillars.

The larvae of the budworm, *Heliothis virescens*, and earworm, *Heliocoverpa zea*, are a major problem in cotton crops, as well as in corn, soybeans, sorghum, sunflowers, tobacco, and peanuts.

Building on previous research findings that beet armyworm caterpillars elicit a chemical SOS response in plants, ARS researchers were surprised to find that budworms and earworms produce the same compounds present in the saliva of beet armyworms.

Oddly, plants are able to distinguish which insect is nibbling on their leaves and give off the proper distress signal to attract that insect's natural enemy.

The scientists hope that by studying plant-insect interactions, they can develop plant varieties with more powerful chemical defenses against insect pests.

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Besides herbicides, the best way to prevent the spread of the noxious weed tropical soda apple, *Solanum viarum*, is to remove the plant and burn it.

Tropical soda apple now covers about 1.5 million acres in the U.S. Southeast, having been spread primarily by cattle, but also by deer and other wildlife.

These animals love to eat the fruit. It passes through their digestive tract, and the seeds are then spread in the feces. The weed can be found growing in pastures, urban areas, vegetable crops, and natural areas in Florida, Georgia, South Carolina, North Carolina, Tennessee, Alabama, Mississippi, and Louisiana. It has also been found in Puerto Rico.

ARS researchers warn not to burn tropical soda apple in a home oven or microwave, because the plant and its fruit produce glyco-alkaloids, a

substance toxic to humans. The best cultural practice for homeowners is removing single plants by hand or clipping or mowing multiple plants. Mowing the weeds several times early in the season and mid-season helps prevent fruit and seed production.

Farmers, landowners, and homeowners can obtain 80 to 90 percent control by mowing every 45 to 60 days. Once the plant is full of fruit, however, mowing could spread seeds.

ARS researchers caution that people should contact a county extension agent first to identify the weed and then to eradicate it as soon as possible.

Weed Science Research Unit, Stoneville, MS
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Several chemical scents that attract Colorado potato beetles have been discovered by ARS scientists.

The beetles are the potato crop's most destructive pest, costing growers millions of dollars in chemical control and crop losses.

For at least 73 years, scientists have been searching for the scent that attracts this yellow-and-black bug to solanaceous plants.

In laboratory tests, when the beetles were offered a choice between one of the newly discovered scents and potato foliage, they were confused and could not tell the difference. The researchers use tiny electrodes attached to the tips of the beetles' antennae to monitor the pests' sensitivity to the potatoes' scent.

In preliminary field tests, the beetles were captured with a synthetic lure containing a mixture of these compounds—something never done before.

The scientists have identified at least five synthetic blends that are attractive to the insects in laboratory tests and that may be attractive in the field as well.

This research could result in the use of naturally occurring chemical signals to monitor and control pest populations. Researchers plan on using this information to investigate how chemical scents, which are emitted when the beetles chew on plants, might help attract potato beetle predators.

Vegetable Laboratory, Beltsville, MD
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New strategies for controlling rosette disease in blackberries could open new avenues for small farmers.

Rosette, or double blossom, is one of the most severe fungal diseases of blackberries grown in the southeastern United States. Many blackberry crops fall prey to the disease, which reduces yields and fruit quality.

ARS researchers found that applying four fungicide applications at 10- to 14-day intervals, beginning about 6 weeks before berries ripen and continuing until 3 days before harvest, controls the disease. They also recommend making a fifth application immediately after harvest.

In the past, farmers have been disappointed with fungicide treatments, because they thought spraying would control the disease in that year's crop. But that's not the case; fungicides applied this year help control next year's rosette problem.

Benomyl is the most effective fungicide tested for controlling rosette, which is caused by the fungus *Cercosporella rubi*. Few fungicides are registered and available for controlling blackberry diseases.

ARS researchers plan to evaluate some new fungicides for controlling rosette. The disease is one of the major reasons southeastern farmers don't grow this specialty crop, which can yield $3,000 to $4,000 an acre.

Overcoming rosette would offer a high-value crop that costs less to establish than strawberries and blueberries.

Small Fruit Research Station, Poplarville, MS
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A natural protein called avidin, found in egg whites, is being developed into a new biopesticide in a partnership between ARS researchers and a Texas agricultural biotechnology company.

The first scientific studies of the protein's lethal effect on stored-product insects were conducted by ARS researchers in the early 1990s. Avidin binds up biotin, an essential vitamin for insect growth, creating a vitamin deficiency that stunts the insects' growth or kills them.

More recently, ARS scientists demonstrated the toxicity of transgenic avidin corn to most insect pests that damage grains during storage. When present in corn seeds at about 100 parts

per million, avidin prevents development of the maize weevil, lesser grain borer, warehouse beetle, sawtoothed grain beetle, red flour beetle, confused flour beetle, flat grain beetle, Indianmeal moth, Mediterranean flour moth, and Angoumois grain moth.

Only one species, the larger grain borer, tolerates the protein.

ProdiGene, Inc., College Station, TX, produces the transgenic corn containing avidin. Avidin is relatively nontoxic to animals and humans.

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A wild Mexican cousin of the potato may be a good source of resistance against *Phytophthora infestans*, the fungus that causes late blight and resulted in the Irish potato famine.

ARS researchers have crossed a heretofore uncrossable bridge: mating a wild Mexican species—*Solanum pinnatisectum*—with a derivative of a commercial potato variety, using a technique known as embryo rescue. A hybrid from the rescue can serve as a parent in a subsequent mating with the cultivated potato.

A second technique has helped to further open up the gene pool from wild Mexican species. The researchers crossed *S. verrucosum*, which is compatible with derivatives of common varieties, with the same group of Mexican uncrossable species.

This mating yielded several new hybrids, which have been crossed to a range of wild relatives and to derivatives of common varieties.

The techniques represent two ways to make new hybrids via sexual means and incorporate them into the commercial potato.

Using fungicides to control recent late blight attacks has sharply increased production costs by nearly $200 an acre for potato growers in Idaho, Washington, North Dakota, Colorado, Oregon, Minnesota, Michigan, Maine, and Wisconsin. Some new strains of late blight have emerged that are resistant to what used to be the most effective fungicide, metalaxyl.

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IPM/Biological Control

Microbial "weed wackers" imported from abroad could be in store for yellow starthistle, mile-a-minute, and other invasive plants that have encroached on crops, rangeland, parks, pastures, and privately owned lands.

The microbes, which include fungi, bacteria, and viruses, for example, sicken the destructive weeds by causing disease. Because they are of foreign origin, like their weedy hosts, the microbes undergo a battery of tests to ensure they'll pose no danger to crops, domestic plant relatives, or the environment.

The biocontrol "boot camp" in which such studies take place is the ARS Foreign Disease-Weed Science Research Unit in Fort Detrick, MD. The nation's largest facility for studying whole plants under microbial containment conditions, the ARS lab is the first stop in a national, multiagency campaign to reunite invasive weeds with natural enemies from their homelands.

One microbial recruit to pass muster is the rust fungus *Puccinia carduorum* Jacky. Released in 1987 in Virginia, it has since worked with the seed head weevil, *Rhynocyllus conicus*, to hold down exotic musk thistle populations—its natural host—that were reduced by up to 90 percent in some regions by the release of the weevil in the late 1960s.

Biocontrol agents like *Puccinia* are seen as long-term alternatives to chemical and other controls because of cost, environmental concerns, and other reasons.

Foreign Diseases-Exotic Weeds Research Unit, Fort Detrick, MD
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A soil-dwelling fungus may be the answer to naturally controlling tiny fly maggots that pester sugar beet crops.

Nearly half the nation's 1.5-million-acre sugar beet crop is treated with granular insecticides to kill the maggot offspring of the fly, *Tetanopsis myopaeformis*.

Unchecked, the quarter- to half-inch-long maggots damage the beet's roots, which supply about 35 percent of the nation's sucrose.

The problem is, some insecticides now used can be toxic to sugar beet seedlings. Also, use of the chemicals can harm nontarget insects in treated soil

areas. As a safer alternative, ARS and U.S. Environmental Protection Agency scientists are testing use of *Synglio-cladium tetanopsis*. It's a species of fungus that infects and kills the maggots.

In lab tests, more than 95 percent of newly hatched maggots died within 5 days of exposure to the fungus. Larger, final-stage maggots lived for several weeks, but few survived.

Small-scale field studies indicate the fungus' cigar-shaped spores could be sprayed or soaked into soil or coated directly onto beet seeds. In host-specificity studies, ladybugs, lacewings, Colorado potato beetles, and other nontarget insects survived exposure to the fungus, indicating that it's highly selective.

Researchers are now seeking a commercial company to help further explore the fungus' potential as a biological pesticide product.

Molecular Plant Pathology Laboratory, Beltsville, MD
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A tiny moth from Australia is the first insect sent to the United States for possible use in fighting Old World climbing fern, an invasive weed that threatens Florida's Everglades and other native ecosystems.

The fern, *Lygodium micro-phyllum*, blankets trees when it climbs up their trunks, creating massive, high walls of light-green vegetation. It smothers lower growing plants by forming a tough, spongy mat.

The moth, currently known as *Cataclysta camptozonale*, measures only one-half inch from wingtip to wingtip. Its slender, wormlike larvae munch on fern leaves. Scientists at ARS' Australian Biological Control Laboratory subjected the insect to rigorous tests with climbing fern and 14 other fern species, then sent more than 250 moths for other tests by ARS researchers in Florida and their University of Florida colleagues.

If follow-up tests at the U.S. and Australian labs confirm that the moth won't harm native or crop plants, scientist may seek federal and state permission to set the insect free at fern-infested sites in Florida.

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A new flea beetle species found in Russia has potential to control the noxious, invasive leafy spurge weed.

First identified in the United States in 1827, leafy spurge, *Euphorbia esula*, now infests at least 5 million acres in 35 states and Canadian provinces. The weed degrades grazing lands for livestock and wildlife and reduces land values. At least six species of flea beetles belonging to the genus *Aphthona* have been introduced and released in North America as control agents for leafy spurge.

Now, ARS scientists working with Russian and Italian researches have discovered, described, and illustrated a new species, *A. russica*, and distinguished it from related species—especially those which feed on leafy spurge. Their report includes new information on several other species of *Aphthona* that could be used in biological control of weeds.

Correctly identifying the new beetle will aid foreign exploration for other new beneficial insects, quality control of laboratory cultures, and follow-up assessment of the spread and impact of beneficial insect species released for biological control of weeds.

Systematic Entomology Laboratory, Washington, DC
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Two new insects may join the dozen existing biological control agents against leafy spurge, *Euphorbia esula*, thanks to ARS research in Europe.

ARS scientists in France have discovered that a midge, *Spurgia capitigena*, lays eggs near the tip of leafy spurge stems. Developing larvae cause the plant to form a swelling, or gall, and turn up its leaves. The gall, which provides food for the midge larvae, reduces the weed's ability to produce seeds. The researchers have obtained necessary permits and hope to release the midge early this summer.

A stem-boring beetle, *Thamnurgus euphorbiae*, is next in line on the spurge control team. ARS researchers at the European Biological Control Laboratory and cooperators showed that the Italian beetle tunnels into spurge stems to lay eggs. The larvae that hatch chew into the stems, weakening the plant and reducing seed production.

The beetle has gained support from the Technical Advisory

Group for Biological Control Agents of Weeds, an independent committee that counsels the USDA's Animal and Plant Health Inspection Service on whether to approve release of a pest control agent. If APHIS grants a permit, the beetle could be released in 2001.

Both insects have been tested for efficacy against spurge and to ensure they will not harm other vegetation. Unlike existing agents, the new midge and beetle are expected to thrive in sandy, shady, or moist soils. That should give land managers new options for spurge management along streams and rivers.

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European Biological Control Laboratory, Montpellier, France
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Listening to the loud munching sounds of Asian longhorned beetles may give scientists a clue as to which trees are infested. This is just one of several new tactics that ARS scientists are exploiting to find ways to control or destroy these wood-boring pests.

First found in the United States infesting trees in New York in 1996 and in Chicago in 1998, Asian longhorned beetles (ALB) have been intercepted at ports in 17 states. If *Anoplophora glabripennis* spreads unchecked into U.S. urban and forest landscapes, it could cost billions of dollars in damage. So far, the only solution to the problem has been to cut down and remove infested trees.

An ARS entomologist in Newark, DE, is fast becoming one of the world's experts on these pests. To date, he has uncovered new information never before recorded on ALB behavior. He and colleagues at the State University of New York-Syracuse are working with a specialist on a feeding noise recognition system. It would generate an acoustic "fingerprint" as the beetle larvae feed within the two different tree tissues that they commonly inhabit—inner bark and inner wood.

Scientists are also developing an archive of the insect-munching sounds created by other chewers, such as carpenter ants, within ALB-infested trees. They hope to have a functional prototype detection system by early this fall.

Beneficial Insects Research Laboratory, Newark, DE
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A trip to Mexico in the summer of 1999 has resulted in the discovery of several natural biocontrol parasites of a new, invasive insect pest.

In July 1998, a scientist confirmed that an insect collected from a hibiscus plant in Bradenton, FL, was *Paracoccus marginatus*—the papaya mealybug. The Bradenton sample was the first time the papaya mealybug had been found in the continental United States.

It's considered to be a serious pest of papaya on several Caribbean Islands and has also been reported to damage papaya and cassava in Mexico.

In June 1999, APHIS sent the expert to Mexico to search for possible controls. The experts collected 40 samples of parasites that included three wasps with potential as biocontrol agents.

Live samples of the wasps and other potential biological control agents were also sent to ARS scientists in the Beneficial Insects Research Unit at Newark, DE, where the parasites could be reared in quarantine.

After screening them and studying their life cycles in living cultures, the Newark scientists have obtained APHIS approval to ship wasp populations to St. Thomas, the U.S. Virgin Islands, where APHIS released them this spring in papaya fields for monitoring and behavioral studies.

Systematic Entomology Laboratory, Beltsville, MD
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Natural enemies of the Russian wheat aphid are now established in six states.

Ten years after ARS scientists and collaborators released millions of exotic wasp parasites in small grain fields in eastern Colorado to control the Russian wheat aphid, they've found that four wasp species have become established in six states.

Since invading the United States in 1986, the green, 1/16-inch-long Russian wheat aphids have caused more than $1 billion in insecticide costs and related losses. Conventional breeding has produced aphid-resistant wheat varieties, which are now available to producers.

In 1988, to screen natural controls for the Russian wheat aphid, ARS scientists worked with a consortium of federal and state scientists to release 11 species of wasps.

Key to the success of the project was the collection of these exotic enemies by the staff of the ARS European Biological Control Laboratory, Montpellier, France.

The wasps were released in the wheat- and barley-growing areas of the western United States. The 11.8 million parasitic wasps released represented more than 80 geographic strains collected from 25 different Eurasian countries where the aphid originated.

From 1991 through 1993, ARS scientists working with USDA's Animal and Plant Health Inspection Service, the Colorado State Agricultural Experiment Station, and the Colorado Department of Agriculture conducted an intensive biological control release program. Its purpose: to establish natural enemies of the aphid in small grains in eastern Colorado.

That group released seven wasp species into Russian wheat aphid-infested wheat fields.

Now, 7 years later, ARS scientist report that four of the seven wasp species have become established throughout a six-state area—Colorado, Kansas, Montana, Nebraska, Oklahoma, and Wyoming. Three species were found parasitizing greenbugs—an aphid relative—on sorghum. Two species successfully parasitized the Russian wheat aphid on wild grasses that aphids used as host plants over summer.

Establishing natural enemies as part of integrated pest management systems is important because they do not cost anything, are highly compatible with plant resistance, and can contribute considerably to the overall reduction in the reliance on insecticides to control aphid cereal pests.

Plant Sciences and Water Conservation Research Laboratory, Stillwater, OK
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ARS and Louisiana Tech University scientists have found that a fungus which grows on the sicklepod plant effectively controls kudzu.

Kudzu is a weed native to eastern Asia that has crept over more than 7 million acres in the United States. In greenhouse and field studies, the scientists found that the fungus *Myrothecium verrucaria* killed 100 percent of kudzu. In ARS tests, the fungus effectively controlled the weed at different growth stages and under varying physical and environmental conditions.

The weed was originally promoted for erosion control and as an inexpensive forage for livestock.

It is now present from Florida to New York and westward to central Oklahoma and Texas, with heavy infestations in Alabama, Georgia, and Mississippi.

The weed resembles a giant beanstalk. It spreads about 120,000 acres a year, and control costs increase by nearly $6 million annually. Typical—but not highly efficient—control methods include treating with herbicides and mowing. Many consumers are reluctant to spray herbicides, and mowing doesn't kill the weed's underground root system.

ARS' bioherbicide appears to invade the plant's roots. The researchers are doing extensive toxicological studies on the fungus and plan to pursue a patent.

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Plant Genetic Resources

The smooth, soft, durable fabrics woven from pima cotton make high-quality, long-lasting clothing, as well as luxurious sheets, towels, and other cotton goods.

Thanks to work by ARS scientists, tomorrow's pima plants may endure blistering desert heat better than today's varieties and produce higher yields.

About a decade ago, ARS and University of California—Los Angeles scientists discovered that some pima plants keep leaf pores—called stomates—open longer than others. That's unusual among desert plants, which typically close their stomates as the day gets hotter. Yields of these cooler plants were higher than those from many other pima types tested.

Now, a research team at New Mexico State University has built on that work. They pinpointed genetic markers that may in turn lead to genes which control the cooling-off trait. Once that happens, those genes could be shuttled into plants lacking the trait. That would give pima plants a new, natural means of producing high yields in spite of blazing-hot summer days.

The 1999 pima crop, produced in California, Arizona, New Mexico, and Texas, was worth about $273 million to growers.

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Crop Genetics and Production Research Unit, Stoneville, MS
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Popular Latin American and Caribbean beans may offer new opportunities for U.S. bean growers, thanks to a collaboration between ARS and the International Center for Tropical Agriculture, or CIAT, in Cali, Colombia.

CIAT develops breeding materials for farmers in member countries. ARS researchers evaluated much of CIAT's germplasm to find breeding lines suitable for U.S. growers. Researchers at Colorado State University-Fort Collins and the University of Idaho-Kimberly also collaborated on the project.

The team found germplasm in at least nine market classes that shows promise for this country's cooler climates and longer day lengths. Some are practically ready to plant now. With others, breeders would have to develop domestic varieties that could better withstand U.S. environmental conditions.

Most of the beans would be exported, but the domestic market could benefit, too. Consumers may already enjoy farofa, a dish with beans and cassava flour found at a few Brazilian restaurants. A soup, frijoles garras, is on the menu at some national beef restaurant chains. And nearly all Mexican restaurants serve refried beans.

The foreign germplasm might also help breeders improve market classes grown here, such as by incorporating heat resistance from a Latin American bean into domestic kidney bean varieties.

Vegetable and Forage Crop Research Unit, Prosser, WA
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A potato virus collection serves as a "411 directory" for plant pathologists, breeders, geneticists, and growers.

The ARS Schultz Potato Virus Collection maintained by the Vegetable Laboratory in Beltsville, MD, includes 17 distinct viruses. They include mild mosaic, apical leafroll, calico mosaic, Aucuba mosaic, leaf rolling mosaic, latent virus, rugose mosaic, spindle tuber viroid, yellow dwarf, and yellow spot.

Researchers throughout the world have compared their infected plants with those maintained in the Schultz collection, started in 1916 at Aroostook State Farm at Presque Isle, ME.

After more than 80 years, the collection still contains progeny from the original infected plants.

Viruses are maintained in insect-proof cages to avoid both contamination by aphid-transmitted diseases and loss of original viruses.

Each year the viruses are grown out in small, screened-in cages in the field to keep the collection going for future use. The researchers save four tubers from each cage for replanting at Aroostook Farm the following year and send the remaining tubers to Beltsville for further use and study.

All of the collection's viruses are among the most prevalent in the United States, Canada, and Europe. A new Carla virus, isolated from the potato variety Red Lasoda in 1992, was named potato latent virus in 1998. It was added to the collection last year.

Researchers can request samples of any virus for study.

Vegetable Laboratory, Beltsville, MD
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A record-breaking 90,100 bees and other pollinating insects from around the globe were identified by entomologists at ARS' bee museum in Logan, UT, last year.

The museum is part of the ARS Bee Biology and Systematics Laboratory. Museum scientists help other researchers—as well as seed growers, beekeepers, farm advisers, homeowners, and agricultural inspectors at airline terminals or shipping ports—identify bees found in fields, orchards, homes, or cargo, for example.

Year-round, the scientists receive a steady stream of requests for help. Last year's detective work included determining the identity of 15,100 specimens sent in from the United States and abroad, as well as another 75,000 specimens netted in investigations by the museum team itself or by ARS colleagues at the laboratory.

The bee museum, officially known as the U.S. Pollinating Insects Collection, is one of the world's 10 most important bee collections.

It houses nearly 1 million specimens from the United States, Mexico, Costa Rica, Spain, and several other countries.

Bee Biology and Systematics Laboratory, Logan UT
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Gulfprince, a new peach ideal for shipping and canning, makes its premier debut this season in nurseries.

This early-season fruit will be just peachy for consumers, because it packs more flavor and aroma. This is owing to Gulfprince's unique slow-softening, nonmelting type of flesh.

This characteristic allows growers to leave Gulfprince on the tree longer to continue ripening, while still retaining sufficient firmness for shipping. Because the peach industry is powered by aroma, this new variety—with its tree-ripened scent—should be a hit.

Gulfprince is the first nonmelting-flesh cultivar released from the joint regional breeding program—including USDA, the Universities of Georgia and Florida—based at UGA's Attapulgus Research Farm near Bainbridge, GA.

Gulfprince ripens in early June just as Georgia peaches swing into production. This large, vigorous fruit has good sweetness and doesn't brown easily when bruised—a plus, because browning spoils the appearance of the fruit when cut or processed.

Gulfprince will also make a wonderful addition to peach orchards in mid-February, when its showy pink flowers are in bloom.

The scientists have filed for a joint plant protection patent.

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Quarterly Report

of Selected Research Projects

United States Department of Agriculture
Agricultural Research Service

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Contact the scientists listed for further information on each research project. For general questions about this report, contact Hank Becker, ARS Information, 5601 Sunnyside Avenue, Beltsville, MD 20705, (301) 504-1624, hbecker@.ars.usda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact ARS Office of Technology Transfer, 5601 Sunnyside Avenue, Beltsville, MD 20705-5131. Questions about a company's product and/or research should be directed to the company itself.

This publication is available on the World Wide Web at http://www.ars.usda.gov/is/

Into the Marketplace

ARS researchers recently announced the release of the first new redbud cultivar developed at the U.S. National Arboretum, Washington, D.C. The new cultivar, named Don Egolf, is a variety of *Cercis chinensis*, or Chinese redbud.

The new redbud's profusion of rosy-purple flowers, compact structure, ease of propagation, seedlessness, and apparent high tolerance to *Botryosphaeria dothidia* canker have made it a welcome newcomer to nurseries across the country.

Since 1994, cooperating nurseries throughout the eastern, southern, and midwestern United States have evaluated Don Egolf with high acclaim. Its ease of propagation by rooted cuttings is an especially valuable trait because redbud cultivars are notoriously difficult to propagate.

Because the cultivar is seed-sterile, it produces no fruit, enhancing the shrub's appearance during winter. The new redbud has a compact, vase-shaped, multi-stemmed structure and is hardy in USDA zones 6 to 9. Its dark green, pest-resistant leaves turn yellow in autumn.

The prolific bloom, structure, and foliage of Don Egolf make it well suited as a specimen plant, as a part of mixed plantings, or as a highlight at the edge of woodland plantings.

Floral and Nursery Plants Research Unit, Beltsville, MD
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ARS researchers have now released a new lilac (*Syringa*) cultivar called Betsy Ross. This is the first release from ARS' lilac genetic improvement program.

The Betsy Ross cultivar was developed from a cross using the lilac *Syringa oblata*, which was collected in China in 1976. Starting in 1992, the Betsy Ross lilac was released to cooperating nurseries throughout the United States to confirm its superior performance.

Its fragrant white flowers, lush green foliage, compact growth habit, disease tolerance, and adaptation to warmer climates ensured its success. One significant advance has been the new lilac's outstanding resistance to powdery mildew, the biggest disease problem for lilacs in the Washington, D.C., area.

The new shrub thrives under full sun and can be used as a background planting in a shrub border, as a specimen

plant or hedge, or as a mass-planting throughout USDA hardiness zones 5 to 7.

Genetic material from this new cultivar will be deposited in the National Plant Germplasm System to make it available to researchers and others interested in developing and commercializing new cultivars.

Floral and Nursery Plants Research Unit, Beltsville, MD
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Cooperative Research and Development Agreements

...With Orsetti Seed Co., Inc., Hollister, CA, to evaluate ARS-developed broccoli breeding lines to determine their potential as true-breeding varieties and as parental lines for developing hybrids.

The new lines were developed by ARS scientists in Charleston, SC. Because California produces about 90 percent of U.S. broccoli, testing in that state was needed to determine the full potential of these new lines. The U.S. broccoli crop is worth about $500 million annually.

After testing in South Carolina, ARS sent the lines to Orsetti cooperators in California, who planted them in fall and winter for three years. In 1997 and 1999, excessive rainfall significantly damaged winter field trials. But in the other field tests, each line was evaluated for many characteristics, including uniformity; height; days to maturity; head extension, color, shape, firmness, and smoothness; incidence of downy mildew; overall head quality; and other important traits.

Typically, Orsetti selected for retesting 5 to 10 broccoli lines out of the 50 sent each year, or the company used them as parents to develop new hybrids. Inbreds were tested every year, while hybrids were tested in the second and third years.

Although no new hybrid cultivars have been developed so far, Orsetti continues to further test several ARS inbreds. In addition, they are continuing to test several hybrids that used an ARS inbred as one parent, combined with one of their own.

U.S. Vegetable Laboratory, Charleston, SC
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...With BioGuard Research and Development, Inc., Kennewick, WA, to develop food attractants for German cockroaches (*Blattella germanica*) and repellents for foraging fire ants (*Solenopsis invicta*).

The German cockroach is the no. 1 indoor insect pest. Cockroach feces, saliva, eggs, and skin left behind on surfaces contain allergens that can be health-threatening to people with asthma. Early roach detection is critical to preventing allergen production and accumulation.

Current trapping technology lacks long-lasting, potent attractants to lure roaches into traps. The CRADA partners hope to develop an effective slow-release attractant. Slow-release formulations make traps effective longer and allow early detection of infestations.

Ways to repel fire ants, especially from utilities, are also urgently needed. Fire ants forage for food in many places, including telephone switchboxes, air conditioning units, and other electrical equipment. They chew off equipment insulation and may electrocute themselves, releasing pheromones that attract more ants. These ants are also electrocuted. Eventually, dead ants accumulate and short out the electrical system.

Part of the agreement will be to further develop ARS patented fire ant repellents into slow-release formulations that could prevent the pests from entering these systems.

Center for Medical, Agricultural, and Veterinary Entomology, Gainesville, FL
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...With Mycotech Corp., Butte, MT, to develop isolates of the fungus *Beauveria bassiana* as effective, safe, and environmentally friendly controls for moth pests of vegetable crops.

The pests include diamondback moth, European corn borer, corn earworm, fall armyworm, and beet armyworm.

ARS scientists are conducting laboratory assays to charac-

terize the effectiveness of about 50 fungal isolates against the larvae of each pest. In the summer of 1998, the scientists conducted small field trials of five selected isolates of *B. bassiana*. Each isolate was tested against three pests in four field plots totaling about one-quarter acre.

In 1999, several novel formulations of the most effective isolate were field-tested against diamondback moth and fall armyworm. The isolate was also tested in combination with a new *Bacillus thuringiensis* product.

Field and greenhouse experiments are planned to compare effectiveness of exposing moths to direct sprays of fungal spores and to spores sprayed on plant foliage. A new isolate of *B. bassiana* obtained by Mycotech through an Asian collaborator was found to be highly pathogenic to an exceptionally broad range of moth pests.

However, the strong biological control potential of this isolate was discovered too late for inclusion in the 1999 field trials.

U.S. Plant, Soil, and Nutrition Laboratory, Ithaca, NY
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...With Phelps Dodge Refining Corp., El Paso, TX, to determine the effectiveness of copper sulfate in protecting channel catfish eggs from saprolegniasis, a fungus disease.

Without some preventive action in U.S. fish hatcheries, less than half the estimated one billion catfish eggs produced each year would never become small fry to stock ponds, much less tasty entrees. The egg-destroying culprits in hatchery tanks are cottony waterborne fungi, which can cause much of the investment in 4- to 8-year-old catfish broodstock to go down the drain.

Since the 1980s, fish farmers have had only one Food and Drug Administration (FDA)-approved therapeutic drug, formalin, to save the eggs. Copper sulfate is a less expensive, less smelly substance that's easier to apply safely than formalin.

But does copper sulfate work without harming the young hatchlings? That's a question being addressed by the CRADA. Before entering the agreement, Phelps Dodge was seeking FDA approval for copper sulfate as a treatment for ichthyopthiriasis, a parasitic disease of fish. FDA restricts use of therapeutic agents to diseases defined in an approved label claim, and only commercial companies are allowed to formally apply for FDA approval of their products.

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Patents

ARS has filed a patent application on active substances in cinnamon that wake up body cells to the hormone insulin--in test tube studies.

Because insulin regulates glucose metabolism and thus controls the level of glucose in the blood, the substances may have the potential to delay or prevent adult-onset, or type 2, diabetes.

Nearly 6 percent of the U.S. population–15.7 million people–have diabetes, and one-third of them don't even know it. The large majority of diabetes cases are type 2, the kind that emerges when body cells fail to recognize and respond to insulin as well as they once did.

The most active of the cinnamon compounds–methylhydroxy chalcone polymer (MHCP)–increased glucose metabolism roughly 20-fold in the test tube assay of fat cells. Whether it will be effective in people remains to be tested.

MHCP and the other active compounds are water soluble and so are not found in the spice oils sold as food additives.

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Soil, Water, and Air Quality

Odors from cattle feedlots may one day be abated by some essential oils–chemicals like those produced by some aromatic plants.

In laboratory experiments, ARS scientists essentially blocked the formation of foul-smelling volatile fatty acids when they applied as little as 1 gram of the essential oils carvacrol or thymol to half-liter slurries of cattle feces and urine.

Carvacrol and thymol are constituents of oregano oil; they can also be found in thyme and many other common herbal plants.

Commercially, the compounds are synthetically produced, and they are often minor ingredients in foods and personal care products.

The research also showed these essential oils can reduce populations of fecal bacteria in manure slurries.

Now, the scientists are taking their research to the real world–the feedlot–where they will test the essential oils against odor production and the potentially deadly fecal bacterium *Escherichia coli* O157:H7 and other pathogens.

When pathogen-laden manure gets on the hides of cattle headed for slaughter, the risk of meat contamination during slaughtering increases.

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A 3-year survey of eastern North Carolina farm wells resulted in good news for residents concerned about drinking water quality.

ARS scientists collected water samples monthly from 92 shallow groundwater wells from March 1993 to March 1995 and quarterly for the remainder of 1995 and early 1996.

The wells were located on the 5,041-acre Herrings Marsh Run watershed in Duplin County, NC. Most of the watershed is farmed with row and truck crops. The region is regarded as having a high potential for groundwater contamination because of high rainfall, shallow water tables, sandy soils with low organic matter content, and high pesticide usage.

The 2,598 water samples were initially screened for 11 pesticides–8 triazines, 2 chloroactamides, and 1 methylester–using immunoassay techniques. The scientists further analyzed the 266 positive detections using gas chromatographic and mass spectrometric procedures.

During the study period, pesticides were consistently detected in only 4 of the 92 farm wells. And those pesticide residue concentrations were well below the health advisory or maximum contaminant levels.

The survey revealed that commonly used pesticides had a minimal impact on the quality of drinking water in the area.

The low amounts of pesticide residue may be due to several factors. The quantity of certain pesticides applied may have decreased because of a shift from growing corn/soybeans to cotton and because best management practices were used to apply the pesticides.

Coastal Plains Soil, Water, and Plant Research Center, Florence, SC
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Fungi known as basidiomycetes—the same group that includes edible mushrooms—may play a key role in maintaining and improving soil quality.

In many basidiomycetes, the underground parts of the fungi—known as filaments and hyphae—produce sugary substances that with the filaments bind soil particles. This binding together, or aggregation, reduces soil compaction and allows roots, oxygen, and water to move through the soil.

Mushrooms are typically associated with cool, damp, forested areas where they help to decompose fallen trees. But an ARS microbiologist found that basidiomycetes are widespread and important components of many types of soils.

In open environments, the underground filaments may be plentiful without producing aboveground mushrooms, so their role is not well understood. Basidiomycetes are the second largest group of fungi known to science.

The fungi survive with or without living plants and thrive on straw or crop

residue left over after harvest. The scientists found greater numbers of the fungi—and better soil—in land that had been cropped without tilling. So in addition to reducing erosion, no-till practices could help improve soil quality by fostering basidiomycete populations that help to better hold soil particles together. The presence and number of these fungi may also serve as a good indicator of soil quality.

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Food Safety and Quality

Fresh-cut apple slices should be available soon to consumers nationwide, thanks to collaborative research between ARS and Mantrose-Haeuser Co., Inc., Attleboro, MA.

The packaged, refrigerated slices last 2 to 3 weeks without browning or losing crispness. Schoolchildren and some consumers already enjoy the new apple treat, and the company plans to expand its distribution nationwide this year.

The key discovery by ARS researchers was that certain calcium salts protect apple slices from color, taste, or texture changes. Scientists at Mantrose-Haeuser took the ARS findings and created a proprietary formulation using FDA-approved vitamins and minerals.

They are marketing the product under the trade name NatureSeal for use by fresh-cut processors and food-service industries.

The equipment necessary to peel, core and slice the apples already exists. The team has patented its methods (Patent No. 5939177).

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Adding a smidgen of oat oil to bread dough could be the secret to making heart-healthy bread that's soft and has an increased loaf size and longer shelf life.

Until now, U.S. bakers have ensured these qualities in most bread by using recipes that include about 3 percent vegetable shortenings and other additives. But oat oil may be a healthier alternative because it doesn't contain trans fatty acids.

Studies indicate that trans fatty acids can raise cholesterol levels in some people. Oat oil is rich in phospholipids and glycolipids, also called polar lipids. ARS scientists found that this type of oil combines with water to lubricate bread dough, helping it rise evenly and bake into a loaf that is uniformly soft and springy, even after several days of storage.

Replacing pure oat oil with just 0.5 percent polar lipids taken from oat oil achieved the same result. Polar lipids worked better in bread made from hard red winter wheat flour—the flour from which most bread is made—than in bread from more costly hard red spring wheat flour.

Because of their high gluten content, doughs made from hard red winter wheat flour need less shortening to increase loaf volume. Currently, the most highly valued major component of oats is the bran.

Oat oil, which comprises about 6 percent of most dehulled oats, now is rarely sold as a commercial product. The new findings about oat oil and breads could potentially lead to a new market for oats.

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Incorporating modified rice starch and other rice ingredients into wheat-based doughnuts, like cake doughnuts, could cut oil absorption during frying by as much as 70 percent.

That's the implication of ARS research in which scientists analyzed the oil content of doughnuts made from all-wheat doughs and a wheat/rice mixture.

Wheat is a popular commercial dough and batter ingredient for fried foods because it forms a crisp, tasty, golden coat. Researchers have found that the rice ingredi-

ents they're testing will do the same, but with the added benefit of reducing oil, which adds more fat to foods like doughnuts during frying.

In trials, scientists fried and then analyzed different batches of doughnuts. One group consisted of plain, 100-gram, all-wheat doughnuts. The other group was made from rice/wheat dough. Compared to the all-wheat doughnuts, which had 24 to 26 grams of oil, the rice/wheat ones had as little as 8 grams.

Used commercially, the approach could expand market outlets for rice and ease some consumer concern associated with eating doughnuts, which generate $4 to $5 billion in annual sales.

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Animal Production and Protection

An on-farm detection kit for *Salmonella enteritidis* has been developed by ARS scientists through a cooperative research and development agreement with Neogen, Inc., of Lansing, MI.

The ARS detection kit allows the egg producer to test birds on the premises without costly procedures, which are now necessary.

Using monoclonal antibodies developed by ARS researchers, the scientists developed and evaluated a test panel kit for rapidly identifying *S. enteritidis* organisms isolated from poultry samples. The panel is able to detect *S. enteritidis* in a diluted egg and chemical mixture spiked with one *S. enteritidis* organism and then incubated for 24 hours at 37 degrees C. The samples are applied directly to the panel, which looks like a home pregnancy test stick. *S. enteritidis* is indicated by a blue line on the stick.

Fecal and environmental samples taken from infected birds gave similar results. Overall, the panels appear to offer the producer a simple means to identify the presence of *S. enteritidis* in samples collected at the farm.

To confirm the lab findings, scientists will conduct further testing in labs that routinely perform *Salmonella* testing for egg producers.

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The recently discovered hormone adrenomedullin can act as an indicator of disease stress in livestock and may be able to serve as a biomarker, ARS scientists have found.

The discovery could keep some contamination out of meat processing–and save producers money.

Adrenomedullin (AM) is a naturally occurring amino acid peptide hormone produced in many tissues, including the adrenal medulla, lungs, kidneys, and heart. It is involved in many physiological and pathological processes.

Increases in the hormone appear to be associated with some forms of infection in cattle, goats, pigs, and sheep, according to the study done in collaboration with the National Institutes of Health. In ARS experiments, calves that harbored internal parasites had 67 percent more AM in their blood than healthy calves.

Monitoring of AM levels may give livestock producers the opportunity to help sick animals recover from illness and make them safe for processing, which would be a plus for the producer and the consumer.

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ARS is launching its National Animal Germplasm Program by storing semen from special research lines of chickens at the National Seed Storage Laboratory (NSSL) in Fort Collins, CO.

The laboratory, opened in 1958, provides long-term storage of seeds and other reproductive plant material known as germplasm.

Today, the location routinely houses nearly 360,000

samples from about 5,000 crop species and their wild relatives.

Germplasm–including semen, embryos, and other tissues--from cattle, swine, poultry, sheep, goats, and fish will also be stored at the site as the main repository for livestock. Researchers and producers will be able to access the germplasm to develop new genetic lines or to reintroduce traits that may have been lost.

ARS scientists in East Lansing, MI, developed breeding lines of chickens with varying degrees of genetic resistance to viral-induced lymphoid tumors. The chickens have been used to help researchers understand genetic resistance to tumors and to test the efficacy of Marek's disease vaccines.

The East Lansing laboratory began storing cryopreserved chicken semen in 1984 and will donate up to half of the samples from each line to the NSSL collection.

Researchers with the new program are developing a comprehensive database of the primary characteristics of livestock breeds and breeding lines. Users will be able to evaluate these breeds for genetic merit across varying environments and production systems.

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A new method for mass-producing white blood cells called macrophages has been developed by ARS animal scientists.

Now, instead of obtaining them by flushing precursor cells called monocytes from an animal's lungs or peritoneal cavity, biomedical and veterinary scientists can culture macrophages using small blood or tissue samples. The amoebalike macrophages originate in bone marrow and reside in various tissues as a first-line defense against germs that cause infection or disease.

They do this by absorbing germs and then adorning themselves with pieces of digested protein. This helps mobilize immune system "T" cells and "B" cells, which make antibodies.

But one swine pathogen, called porcine reproductive and respiratory syndrome virus (PRRSV), infects macrophage cells so it can replicate and spread. In pigs, this can cause late-term abortions, stillbirths, and other problems.

With macrophage culturing, scientists can accelerate research aimed at finding new drugs that might target weaknesses in the virus' biological machinery. In pigs, the approach calls for culturing monocyte cells from blood samples and a layer of feeder cells that promotes growth.

After several weeks, the monocytes mature into hundreds of millions of healthy, dividing macrophages that can either be stored or harvested for immediate research.

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Human Nutrition

A form of inulin, a carbohydrate commonly used as a low-calorie fat substitute in food products, increased the amount of calcium that teenage girls absorbed from test diets containing ample calcium.

That could lead to stronger bones, say researchers. They tested a commercially available form of inulin—Raftilose SDP—supplied by Orafti, the study's sponsor.

During the first 3 weeks, the 29 girls—ages 11 through 14—drank calcium-fortified orange juice containing either the inulin or a placebo as part of a 1,300-milligram calcium diet. Following a 2-week break, the girls repeated the study, with the inulin group then receiving the placebo and vice versa.

While on the placebo, the girls absorbed 416 mg of calcium. But while taking the supplemental inulin, absorption jumped 18 percent to an average of 494 mg. The difference of nearly 80 mg is about the same amount of calcium that a child would normally absorb from 7 ounces of milk.

The researchers believe that inulin could boost the absorption of calcium from diets containing lower amounts of calcium as well.

Natural sources of inulin include onions, asparagus, leeks, garlic, artichokes, bananas, wheat, rye, barley, and chicory.

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A study has shown that elderly Hispanics with diabetes are more likely than non-Hispanic whites to lose muscle and the ability to move around with ease or take care of basic needs.

Researchers studied 556 Hispanic elders ranging in age from 60 to 92, as well as 158 non-Hispanic white subjects living in the same neighborhoods across Massachusetts, for comparison.

Muscle wasting and functional impairment increase the list of known complications that may result from uncontrolled blood sugar–namely heart disease, blindness, kidney failure, and nerve damage in the extremities.

Diabetes is far more prevalent among U.S. Hispanics than among non-Hispanic whites and African Americans. It is also more severe, judging from the number of Hispanics in the study who used insulin rather than dietary changes or less potent drugs to control their blood sugar. And their higher protein and calorie intakes did not translate to higher serum albumen levels, which are often used to indicate general state of health and nutrition.

Public health outreach is needed to educate Hispanics and their health care providers about the serious consequences of diabetes and the need for dietary and lifestyle changes that can prevent or lessen its impact.

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Vitamin B_{12} deficiency may be far more commonplace in the U.S. population than previously thought.

Researchers found that 39 percent of men and women in the ongoing Framingham (MA) Offspring Study had plasma B_{12} levels in the "low-normal" range, below 258 picomoles per liter (pmol/L). More than 16 percent fell below 185 pmol/L, a level where many people may exhibit some signs of deficiency.

And age didn't seem to matter. The youngest group, ages 26 to 49, had about the same B_{12} status as the oldest group, ages 65 to 83. B_{12} deficiency can cause a severe type of anemia. It can also cause walking and balance disturbances, a loss of vibration sensation, confusion, and in advanced cases, dementia.

Eating plenty of fortified cereals or dairy products improved B_{12} status among the 3,000 subjects, although not as well as taking supplements containing the vitamin. Supplement use reduced the percentage of volunteers in the danger zone--plasma B_{12} below 185 pmol/L–from 20 percent to 8 percent. Eating fortified cereals five or more times a week or being among the highest third for dairy intake reduced, by nearly half, the percentage of volunteers in that zone.

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U.S. youngsters today are eating more food--and more calories–than kids did 20 years ago, according to the latest U.S. Department of Agriculture data on the food intakes of nearly 10,000 children nationwide.

ARS nutritionists combined data from a special 1998 nationwide survey of 5,559 children from birth to 9 years old with those from the 1994-96 national survey (CSFII) of all age groups. Trends gleaned from the combined data generally concurred with the 1994-96 findings.

Snacks contributed a significant percent of daily calories—around 20 percent, on average. Among the most frequently reported snacks for the ages 9 and under were milk, fruits, cookies,

candies, crackers, popcorn, pretzels, and corn chips. Eighty-three percent of kids snacked on the day surveyed, up from 65 percent in the 1977-78 survey.

Over the past two decades, soft drink consumption increased 21 percent among 2 to 5 year olds and 37 percent among 6 to 9 year olds. Both age groups also drank more fruit juices and fruit drinks—26 percent and 11 percent more, respectively.

Milk consumption, on the other hand, dropped 4 percent among the preschoolers and 10 percent among the older group.

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Boron and potassium may play a key role in keeping bones strong and healthy.

A new study by ARS and the University of California at Davis scientists may help determine whether consuming foods that provide these minerals can help stave off severe bone loss, or osteopororis. An estimated 10 million Americans have osteoporosis.

Results from animal and human studies elsewhere suggest that boron may help keep bones strong, but scientists don't know exactly how.

Potassium, in the form of potassium bicarbonate, may help by offsetting buildup of natural acids formed when the body eats high-protein foods.

To reduce acid loads, the body may leach calcium–an alkaline compound–from within bones. Potassium bicarbonate, the main form of potassium in some fruits and vegetables, is alkaline, and may help neutralize acids, thus helping to prevent leaching.

Researchers plan to work with about 90 healthy, postmenopausal women for the investigation.

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More evidence that vitamin K helps maintain strong bones comes from a new look at data from 888 elderly men and women who participated in the Framingham Heart Study between 1988 and 1995.

Those who reported the lowest daily vitamin K intakes in 1988 experienced significantly more hip fractures by the 1995 examination than those reporting the highest intakes. There was no relationship between bone mineral density and vitamin K intakes, however.

Dark green leafy vegetables, like spinach and broccoli, are rich in vitamin K—known chemically as phylloquinone. One serving of spinach or two servings of broccoli provide four to five times the Recommended Dietary Allowance of 65 to 80 micrograms daily. The lowest intakes in this study averaged 56 micrograms; the highest 254 mcg.

The new findings support others reported in 1999. Analysis of data from more than 72,000 women in the Nurses' Health Study showed that low vitamin K intakes increased risk of hip fracture.

Researchers at the ARS-funded center in Boston collaborated on the new study with researchers from the Hebrew Rehabilitation Center for Aged Research and Training Institute, Harvard Medical School, and others.

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People who already eat a low-fat diet to reduce cholesterol might lower it more by consuming products with high levels of plant sterols.

That's what happened when the 53 men and women in a study consumed low- and reduced-fat salad dressing containing soybean sterols as part of a low-fat diet.

Cholesterol reductions nearly doubled in the volunteers when they consumed 2.2 grams—about one-half teaspoon—of soybean sterols daily for 3 weeks of the 6-week study. A typical American diet provides

approximately 0.25 gram of plant sterol per day—less than one-eighth of the study level.

A number of fat-based foods, such as margarines, have been enriched with plant sterols. While sterols' potential benefits have been studied for decades, this study was unique in examining them as an ingredient in low-fat foods and as part of a tightly controlled low-fat diet. It was partly funded by Lipton. Similar in structure to cholesterol, the sterols most likely lowered the volunteers' cholesterol by limiting its intestinal absorption.

The volunteers began the study with their levels of "bad" (LDL) cholesterol in the mildly elevated range.

The low-fat diet alone reduced their total and "bad" cholesterol levels 7.3 and 8.4 percent, respectively. With the sterols, reductions were nearly double: 14.1 and 18.2 percent.

Curiously, cholesterol dropped in 5 of the 53 volunteers only when they got the sterol esters. Many people with high cholesterol don't respond to a low-fat diet and rely on cholesterol-lowering drugs. The question is: Could dietary plant sterols also help these people?

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Crop Productivity

Twenty honeybee queens imported from Russia's eastern Primorsky region could soon become matriarchs of a new generation of U.S. bees that resist varroa mites.

ARS scientists imported the queens from Primorsky because heavy mite selection pressures there have forced the insects to develop natural defenses. In the United States, feral and managed bees lack sufficient natural resistance to the mite, which has become an invasive species here. Severe infestations of the blood-sucking parasite can destroy a hive unless checked with chemical miticides.

But the cost of miticides, concerns over handling them, and the potential for mites to develop resistance have fueled the search for bees that can withstand the parasite on their own.

Summer 2000 marks the third time ARS researchers have imported Russian queens as a source of mite resistance for domestic bees, which pollinate about $14.6 billion worth of crops.

In spring 2001, ARS researchers will put the Russian queens and their American hybrid offspring to the test by infesting their hives with hundreds of varroa mites. Next, 40 daughter bees from the sturdiest hives will be shipped to commercial apiaries in Louisiana, Mississippi, and Iowa for further evaluation.

Honey Bee Breeding and Genetics Physiology Research Unit, Baton Rouge, LA
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Pecan growers will appreciate a new, strong-growing pecan variety that produces high-quality nuts and has natural resistance to scab disease.

The new variety, Nacono, was developed by ARS and the Texas Agricultural Experiment Station. Nacono results from a cross between the Cheyenne and Sioux varieties both well-known to growers for their high-quality nuts and scab resistance.

Nacono's natural scab resistance allows it to be grown in most southern U.S. pecan-producing states and in most other pecan-production areas of the world. Scab is a fungal disease that attacks both nuts and leaves.

For disease control, some growers spray fungicides as many as 10 times a year.

Many rural landowners in the Southwest and Southeast derive primary or supplemental income from growing pecan trees in orchards or woodland pastures. In 1999, U.S. pecan production was about 342 million pounds, with a value of nearly $448 million. Georgia, Texas, New Mexico, Arizona, and Louisiana are the top five pecan-producing states.

Nacono will be available only to nurseries in February 2001. Nurseries could have trees to sell to the public in early 2003. Trees of this variety will be incorporated into the USDA-ARS National Plant Germplasm System. The database for the National Plant Germplasm System can be found on the World Wide Web at http://www.ars-grin.gov/npgs/.

USDA's is the only national pecan breeding program in the world.

Crop Germplasm Research Unit, College Station, TX
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ARS researchers have released a new soybean germplasm line, DT98-2448, that naturally resists velvetbean caterpillar (*Anticarsia gemmatalis*) and soybean looper (*Pseudoplusia includens*), two major soybean leaf-eating pests.

The new line will give soybean breeders more options for developing insect-resistant, high-yielding soybean varieties.

DT98-2448 was developed from parentage that includes crosses with DP3589, a commercial cultivar adapted to the clay soils of the lower Mississippi River Valley, and with germplasm originating from Japan.

Velvetbean caterpillar moths fly into soybean field crops when the weather warms and lay up to three generations of larvae during the growing season. The caterpillars feed on plant leaves, and a heavy infestation can wipe out an entire field in a few days.

Soybean looper caterpillars can also destroy an entire field during a heavy infestation. A single female can lay up to 640 eggs at a time. Soybean loopers are particularly hard to control with insecticides because they have begun to develop resistence.

Soybean breeders and researchers may obtain germplasm for the new line from the ARS scientist listed below.

Southern Insect Management Research Unit, Stoneville, MS
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Corn plants may one day receive a reprieve from European corn borer attacks with the release of a new maize germplasm line.

ARS researchers in Stoneville, MS, and Ames, IA, developed GEMS-0001, which has superior resistance to leaf-eating borers. It naturally repels the pests from feeding on corn plants.

The female borer lays her eggs on the corn plant's leaves. Larvae crawl between the leaf and stalk, feeding on leaf blades, leaf sheaths (the thick portion near the bottom of the leaf), and collars (outside of the stalk). They also bore into the stalks and feed on corn ears.

Damage is estimated at between $192 and $400 million a year in the Corn Belt alone. Total damage throughout the United States is about $1 billion a year.

Insecticides are difficult to use because there is a narrow window of opportunity to spray before the larvae bore into the plant. This new germplasm line, which originated from a tropical maize plant from Peru, not only has good stalk-feeding resistance, but also excellent yield potential.

Breeders and researchers can obtain germplasm from the ARS scientist listed below.

Southern Insect Management Research Unit, Stoneville, MS
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A newly identified class of compounds helps pea plants defend themselves against pea weevils, one of their most important insect enemies.

A team of ARS, university, and industry scientists discovered the compound, "bruchins," which the weevils produce.

The plant comes into contact with the bruchins when a weevil lays eggs on the pea pods. Within a few hours, the plant starts producing a tumor, or gall, at the egg-laying site. By the time the eggs hatch, a large gall or tumor has become a barrier to the larvae, so they can't

burrow directly into the pod and feed on the peas inside.

This is the first time scientists have found chemicals that induce an otherwise healthy plant to form a tumor to resist insect infestation.

The team also found that pea plants must possess a certain gene in order to take advantage of the bruchins.

In the 1990s, other researchers found that pea plants with a certain genetic sequence–named "Np"–formed calluses in response to weevil infestations. But this is the first time that scientists have identified specific chemicals involved in the process.

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Insect Chemical Ecology Laboratory, Beltsville, MD
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ARS researchers have developed a strategy for detecting new Asiatic citrus canker (ACC) infestations.

This bacterial disease–which is primarily spread by wind-driven rain–causes brown blemishes on citrus leaves, twigs, and fruit, resulting in fruit drop and loss of yields and quality. More important, these effects lead to a loss of local, national, and international markets due to quarantines on the transport, sale, and export of fruit from affected areas.

Florida produces 75 percent of U.S. citrus. Worldwide, the United States is second to Brazil in citrus fruit production.

The new strategy being used in a statewide survey to detect ACC is the outgrowth of an 18-month epidemiological study. It showed that the previously used 125-foot zone around infected trees, within which all citrus trees were removed, was insufficient to contain ACC.

The ARS study determined that a 1,900-foot zone–which has become the new regulation–is required to limit further spread of the disease. The study also recommended that a 15-mile-wide by 20-mile-long "sentinel tree" grid composed of 144 existing residential trees of susceptible cultivars be established to detect and prevent the further spread of ACC.

These findings have helped increase the ACC eradication budget to $175 million, with an additional $40 million for payments to growers hit by the disease.

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Crop Diseases and Pests

ARS researchers are building a multiple gene complex that controls different types of rust resistance for incorporation into new wheat varieties.

The genes come from two ancestors of modern wheat: *Aegilops tauschii* (also known as goatgrass) found from Afghanistan to Syria, and *Triticum timopheevii* from Iran, Iraq, and Turkey.

Wheat breeding programs have released disease-resistant varieties in the past. However, many of these varieties–but not all–began to lose their effectiveness in as little as 2 to 3 years because they relied on resistance conferred by one gene.

With the gene complex, varieties with more durable resistance can be developed to help farmers fight leaf rust throughout the Great Plains.

Leaf rust is caused by the fungal pathogen *Puccinia triticina*. In the last decade, growers in the hard winter wheat-growing area of the Great Plains have averaged annual losses of 50 million bushels. With wheat prices running about $3 a bushel, leaf rust has cost Great Plains farmers about $150 million a year.

Besides reducing yields, the disease also seriously affects the milling and baking qualities of wheat flour.

Plant Science and Entomology, Manhattan, KS
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A multinational investigation into the microbe that causes Pierce's disease in grapevines may yield new ways to outwit this destructive microorganism.

ARS and Brazilian researchers are collaborating in a joint project to determine the makeup, or sequence, of all of the genes in the bacterium, *Xylella fastidiosa*, that's responsible for this costly disease. In Northern California, Pierce's disease has chronically attacked vineyards, costing growers an estimated $33 million from 1995 to 1997 alone. In California's Temecula Valley, south of Los Angeles, the disease has led to approximately $6 million in damage to vineyards since 1997. A half-inch-long insect known as the glassy-winged sharpshooter can harbor *Xylella* in its gut, then move the pathogen into plants when it punctures grapevine stems to feed.

Once inside a grapevine, *X. fastidiosa* bacteria multiply, blocking the flow of water and nutrients. Severely infected vines die. Pierce's disease affects wine, table, and raisin grapes. Neither the insect carrier nor the disease harms humans, however.

Brazilian scientists have already sequenced the genome of a related *X. fastidiosa* strain that causes a disease known as citrus variegated chlorosis. In addition to ARS, sponsors of the new research venture are the American Vineyard Foundation, the California Department of Food and Agriculture, and the State of São Paulo Research Foundation.

Scientists expect to finish sequencing the genome of the Pierce's disease strain in less than a year.

ARS National Programs for Crop Production, Product Value, and Safety, Beltsville, MD
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ARS scientists found more than 100 new species of the pathogenic plant fungus *Fusarium* when they recently compared genetic material called DNA from more than 3,000 strains collected worldwide.

Some *Fusarium* species cause stalk rot and ear rot in corn and head blight or scab in wheat and barley. The newly discovered species have left the scientists with questions.

Could these fungi survive in fields of U.S. grain? Should plant breeding programs and quarantine programs take into account genetic information about these fungi?

In greenhouse tests, eight of the new species, mostly of exotic origin, produced scab disease in wheat. The scientists say three of the scab-causing fungi may be native to Africa, three to South and Central America, and one to Asia.

The remaining one, like the common cold, is widespread and may be native to the Northern Hemisphere.

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Growing wheat as a rotation crop when replacing apple orchards may help prevent replant disease, ARS scientists found.

The technique could also serve as an alternative to fumigating the soil with methyl bromide, typically used to sterilize old orchards before planting new ones.

When nothing is done between taking out an old orchard and putting in a new one, the young trees are often stunted and have small, decayed root systems.

In the Pacific Northwest, replant disease seems to be caused by buildup of four types of soilborne fungi.

Soil where apple trees grow supports these detrimental fungi. Some wheat soils, on the other hand, foster growth of a beneficial bacterium, *Pseudomonas putida*.

This bacterium appears to protect young apple roots. ARS has patented use of a strain of this bacterium to prevent replant disease.

The next step is to determine how long wheat would have to be grown before orchard replanting in order to protect new apple trees.

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Boosting organic matter in soil may help create ideal soil conditions for weed-suppressing microbes, called deleterious rhizobacteria (DRB).

Living on, or within a few millimeters of, weed roots, these microbes produce toxins and excessive concentrations of plant growth hormones that put weed seedlings into overdrive, although they normally do not interfere with crop plant growth. This overdrive weakens weeds as the fast-growing root cells rupture and leak.

The DRB thrive by feeding on the substances that ooze from the roots. The weakened weeds are less able to compete with other plants for soil nutrients, moisture, and sunlight and are vulnerable to other control measures.

In laboratory and field experiments at Columbia, MO, ARS scientists researched cultures of DRB associated with the most dominant species of weeds in six different cropping systems. In general, the highest number of weed-supressing DRB came from fields where crops were rotated, chemical applications and tillage were minimal, and organic materials such as compost were added.

DRB fared best in a corn-soybean-wheat-cover crop rotation. An organic strawberry system with compost was a close second.

Cropping Systems and Water Quality Research, Columbia, MO
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A new compound for luring Mediterranean fruit flies into traps stays potent three to four times longer than today's most widely used attractant, ARS scientists have found.

Medfly, or *Ceratitis capitata*, is one of the world's worst insect pests of agriculture. It can attack more than 250 different kinds of fruits, vegetables, and nuts.

Currently nicknamed "minus-ceralure" by its ARS developers in Beltsville, MD, and Hilo, HI, the new compound could dramatically cut the number of times that traps need restocking with a male medfly lure.

Today, state and federal agencies in the United States use about 150,000 traps a year, equipped with an older, ARS-developed compound known as trimedlure.

A procedure developed by an ARS chemist in Beltsville yielded enough minus-ceralure for the ARS outdoor tests in Hawaii, where medfly is already established. The outdoor studies indicated that minus-ceralure is about four to nine times more attractive to medfly males than trimedlure.

Minus-ceralure is one of 16 components, known as isomers, that make up a parent compound called ceralure. Other ARS scientists working at the Maryland and Hawaii labs patented ceralure in 1988. ARS is now seeking a patent for minus-ceralure (U.S. Provisional Patent Application No. 60/176,192).

U.S. Pacific Basin Agricultural Research Center, Hilo, HI
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State-of-the-art technology has been used to identify and pinpoint, for the first time, the fungi responsible for powdery mildew on tomatoes.

In 1999, powdery mildew devastated much of the $1.8 million U.S. tomato crop—particularly that part grown in greenhouses. The organism causing powdery mildew is a fungus that has been difficult to identify.

Only one similar organism was known on tomatoes, and it was reported from Australia.

ARS and a team of international mycologists examined all available specimens of *Oidium* fungi–24 powdery mildew isolates and 29 herbarium specimens gath-

ered from all the continents on which tomatoes are grown. Using scanning electron microscopy, classical morphology, and molecular fingerprinting, they were able to determine the molecular fingerprint of the powdery mildew fungus and identify two species that attack tomatoes.

The study showed that this emerging disease is caused by a previously unknown fungus which is distinct from the one from Australia. The scientists identified and renamed the fungus *O. neolycopersici*.

Naming and describing the fungus gives plant pathologists and others studying the disease a more precise way to communicate about and treat this disease.

Systematic Botany and Mycology Laboratory, Beltsville, MD
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ARS researchers and a colleague in Scotland have adapted a strategy they developed for citrus tristeza virus to more accurately sample large areas for plum pox virus (PPV).

This method, called hierarchical sampling (HS), will be used in the U.S. Department of Agriculture's $1.4 million national PPV surveillance program.

Stone fruits, such as peaches and plums, are highly susceptible to PPV. The value of U.S. stone fruit production was $1.3 billion last year.

Previous sampling methods used for spotting diseases and their causative agents on citrus and other crops are based on the number of infested soil samples, disease lesions on a leaf, proportion of diseased fruit, or number of insects found on each plant.

Unfortunately, the methods don't quantify the amount of disease present in any given tree. HS relies on the theory that it's possible to predict disease at one scale by sampling at another.

By sampling only 6.25 percent of the trees in a given orchard in groups of four trees–the location of the trees in the orchard is critical–and using unique statistical methods, scientists are able to accurately predict the incidence of infection in the whole orchard.

After performing thousands of simulations, researchers have shown HS to be much more accurate at detecting plum pox virus infestation than other sampling methods.

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IPM/Biocontrol

Four bacterial strains show promise as biological controls for take-all, a fungal disease of wheat.

ARS scientists and cooperators at Virginia Polytechnic Institute and State University screened large numbers of diverse bacteria present around wheat roots for their ability to suppress the fungus *Gaeumannomyuces graminis* var. *tritici* (Ggt), which causes take-all. This disease demolishes wheat harvests around the world, causing wheat roots to turn black and die, reducing yields by 50 percent or more, and costing U.S. wheat growers alone millions of dollars in years with severe infestations.

The four bacterial strains that show potential as biocontrol agents will be tested separately and in combination with commonly used wheat pesticides in field trials next year.

Biocontrol of Plant Diseases Laboratory, Beltsville, MD
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One of the mechanisms behind tobacco budworm's growing resistance to *Bacillus thuringiensis* (Bt) toxin may have been uncovered by an ARS scientist.

Bt toxin causes the insect's mature gut cells to swell, burst, and die. Using tobacco budworm midgut cells cultured in the laboratory, the scientist found many of the cultured gut cells were killed by the toxin. But some cells responded to the injury by producing cytokines, substances that signal gut stem cells to

multiply and rapidly produce new mature gut cells.

When the *Bt* toxin was washed from the cultured gut cells, the new healthy cells quickly replaced the dying ones. This suggests that if the dose of *Bt* is insufficient or if the insect has developed a way to more rapidly replace its destroyed gut cells, the insect's midgut will heal and function normally.

This could explain why low doses of *Bt* toxin don't kill insects.

Insect Biocontrol Laboratory, Beltsville, MD
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U.S. corn farmers now have three new products to choose from to control adult corn rootworms.

The products have been evaluated by ARS researchers in several national areawide integrated pest management (IPM) projects, as part of USDA's commitment to reduce reliance on agricultural chemicals.

Rootworms drive up the cost of farming in the Corn Belt and Texas, which ranks seventh in corn production.

ARS researchers in Texas showed that with proper timing and application methods, these three new products can cut corn rootworm damage while having little or no harmful effect on the environment.

The first product evaluated was Slam, made by MicroFlo, Inc., of Lakeland, FL. Slam was based on ARS research in Brookings, SD.

The second product was CideTrak, developed under a cooperative research and development agreement between ARS and Trece Inc., in Salinas, CA. CideTrak uses an insect-feeding stimulant and low-dose toxicants. The third product, Invite, marketed by FFP AgroTech., Inc., Eustis, FL, includes Hawksberry watermelon-juice feeding stimulant concocted by ARS researchers in Beltsville MD.

Both Invite and CideTrak allow farmers to use just one-tenth of the allowed rate of toxicant for pests in corn. ARS' areawide IPM projects, which began in 1994, also include control of codling moths, leafy spurge, and stored-grain insects.

Areawide Pest Management Research, College Station, TX
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A new bioherbicide shows promise as an alternative to methyl bromide for controlling weeds in tomatoes.

Discovered by ARS scientists, the bioherbicide, *Myrothecium verrucaria,* comes from the sicklepod plant found primarily in the southeastern United States.

M. verrucaria controls common purslane, horse purslane, ground spurge, and spotted spurge--all serious weed pests in commercially grown tomatoes.

Tomatoes account for the highest consumption of methyl bromide (23 percent) of all crops. About 3,773 tons are applied annually to tomatoes to control nematodes (tiny worms), insects, and weeds.

ARS researchers treated plots with natural infestations of these weeds with *Myrothecium* before planting Beefsteak tomato seedlings.

Applied in place of methyl bromide, *Myrothecium* eliminated the weeds in several field tests. After 14 days, no weeds were found and the tomatoes prospered.

This research was part of an agency fast-track study to look for alternatives to methyl bromide–a widely used fumigant and ozone depletor. Methyl bromide is scheduled to be banned in the United States in 2005 and worldwide by 2015.

Worldwide, 72,000 tons of methyl bromide are used in preplant and postplant applications and fumigations.

The researchers are also examining several other possible, natural alternatives to methyl bromide for controlling weeds, including *Fusarium solani* and *Colletotrichum truncatum.*

Southern Weed Science Research Unit, Stoneville, MS
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ARS scientists have applied for a patent on a new insect diet that enables researchers to propagate destructive plant bugs that become lab food for beneficial insects.

Scientists can raise pests such as the western tarnished plant bug, *Lygus hesperus*. This insect pest alone accounted for about $71 million dollars worth of cotton crop losses in 1998.

Scientists want to mass-rear *L. hesperus* to serve as hosts for the production of parasitoids that could then be released to help reduce insect pest numbers in the wild.

The key to mass-rearing these ravenous insects in sufficient numbers is developing a replacement for the plants they feed on. Without these special diets, rearing the insects is too costly.

The new diet-fed insects are also used for research on sterile-release programs that had never before included *Lygus* bugs because they couldn't be reared in sufficient numbers. Sterilized plant bugs reared on the diet may mate and produce infertile eggs in the wild.

This technology enhances the agricultural community's ability to mass-produce natural enemies of crop pests and decreases grower dependence on chemicals.

Biological Control and Mass Rearing Research Unit, Mississippi State, MS
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Beneficial strains of *Fusarium* are being used to control *Fusarium* strains that cause wilt. The research is part of ongoing ARS research to use "good guy" biocontrol organisms against pathogens such as the wilt-causing *Fusarium oxysporum*.

The successful tests are good news for tomato growers who need an alternative to the chemical fumigant methyl bromide now used to control wilt. *Fusarium* attacks many vegetables, melons, and other crops, such as basil, causing severe losses. Now, there is a new *Fusarium* strain that attacks tomatoes.

The scientists tested several beneficial strains of *F. oxysporum* against the wilt-causing strain. They found one strain, CS-20, that reduced wilt by 49.6 percent.

They also mixed beneficial strains of a fungus (*Trichoderma virens* strain G1-3) and a bacterium (*Burkholderia vietnamiensis* strain Bc-F).

The fungus-bacterium treatment reduced wilt incidence by 41.6 percent.

And CS-20 and the fungus-bacteria combination treatment significantly increased both the weight and number of tomatoes on the plant.

Biocontrol of Plant Diseases Laboratory, Beltsville, MD
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Plant Genetic Resources

A new species of moth discovered at Wright-Patterson Air Force Base, Fairborn, OH, has been named after Wilber and Orville Wright.

The new species, *Glyphidocera wrightorum*, was found during a survey initiated by the Office of Environmental Management through an agreement with the Ohio Chapter of The Nature Conservancy. Begun in 1992, the survey has listed 28 species of moths never before recorded in Ohio.

Specimens of *G. wrightorum* were collected in 1994 and 1995 on the 110-acre Huffman Prairie by Eric H. Metzler, an entomologist with the Ohio Lepidopterist Society. The prairie is an Ohio-registered Natural Refuge and National Landmark.

ARS scientists identified and categorized the moth as belonging to the genus *Glyphidocera*. They named its species "wrightorum," which is Latin for "of the Wrights." The Wright brothers made their first successful sustained, powered air flights in a heavier-than-air machine in North Carolina on December 17, 1903.

The scientists believe the new species is a living remnant of prairie ecology that existed in Ohio for many centuries. *G.*

wrightorum is one of many species in the genus that are only found in the New World. Nothing is known yet of the moth's host-plant associations. The scientists reported their findings, describing the *G. wrightorum*, in *The Proceeding of the Entomological Society of Washington*, April 2000.

Systematic Entomology Laboratory, Smithsonian Natural History Museum, Washington, DC
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Ruddy, an attractive, red-skinned sweetpotato from ARS and university researchers, is sweet and moist, with excellent baking quality and flavor.

Sweetpotatoes are a highly nutritious vegetable. Medium-orange sweetpotatoes contain very high levels of beta-carotene–more than the Recommended Dietary Allowance of vitamin A–as well as high levels of fiber, vitamin C, and folic acid.

Ruddy is the first attractive, red-skinned, orange flesh sweetpotato with multiple pest resistance to insects, diseases, and nematodes to be developed by ARS scientists working with researchers at the South Carolina Agricultural Experiment Station, Clemson University.

It produces high yields and keeps well under long-term storage.

Ruddy is highly resistant to the larvae of soil insects–the southern potato wireworm, tobacco wireworm, banded and striped cucumber beetle, elongate flea beetle, and pale striped flea beetle. It is more susceptible to white grub larvae than the insect-resistant cultivar Regal.

Ruddy is highly resistant to *Fusarium* wilt and two races of the southern root-knot nematode.

Ruddy is a cross of two parents–maternal parent W119 and one of 30 possible parental clones selected for high levels of multiple-pest resistance combined with good horticultural traits.

Small quantities of foundation seed roots, sprouts, and cuttings of Ruddy will be available to researchers and others for the 2001 crop season. Genetic material can also be obtained from the Sweetpotato Clonal Repository at Griffin, GA.

U.S. Vegetable Laboratory, Charleston, SC
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An experimental line of sugar beets, known as M6-1, can shrug off attack by some of the world's most notorious root-knot nematodes.

This natural resistance to nematodes might be bred into commercial sugar beet varieties to help them fend off these microscopic, soil-dwelling pests. What's more, the gene or genes that enable M6-1 to thwart nematodes might someday be shuttled into other kinds of crops–including peaches, beans, potatoes, or tomatoes–that might otherwise fall victim to the voracious worms.

The M6-1 sugar beets apparently are the first plants in the world known to exhibit resistance to six especially troublesome *Meloidognye* species. These species make up an estimated 98 percent of the root-knot nematodes in the globe's agricultural soils.

A Swiss chard relative, sugar beets provide not only sugar, but also feed for livestock, leafy greens for backyard gardeners, and raw materials for yeast, industrial chemicals, and pharmaceuticals.

The California Beet Growers Association, Ltd., Stockton, CA, helped fund the research.

Crop Improvement and Protection Research Unit, Salinas, CA
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Pima cotton plants that are better able to fend off attack by pink bollworm and silverleaf whitefly–two major pests of cotton in the American West--are among the newest breeding lines offered to seed companies, growers, and researchers.

The plants also are ready to harvest earlier than some other pima types. That reduces the need for water, pesticides, and fertilizers that the plants would otherwise require if they took longer to develop.

Known to scientists as *Gossypium barbadense*, the new pimas result from a highly successful, ongoing collaboration between ARS and University of Arizona researchers. The partnership has yielded more than 200 different pima genetic lines or varieties during the past 40 years. In fact, nearly every type of pima grown commercially today in the United States has some ARS lineage.

Pima cotton is prized because it can be woven into durable, long-wearing fabrics for high-quality clothing or other premium cotton goods.

Breeders of conventional or upland cotton, called *G. hirsutum*, may also benefit from the pima research. That's because–with some extra work–pima and upland cottons can be crossbred.

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Computer Systems and Models

A sophisticated, user-friendly computer model developed by ARS researchers has helped engineers, scientists, and students worldwide understand how water and chemicals move in soil and groundwater.

HYDRUS allows agricultural engineers to design irrigation systems that provide optimal water to crops, while minimizing the transport of fertilizers and pesticides to groundwater. Landfill designers have used the program to ensure their facilities do not release contaminants.

Dozens of scientists and students contributed to HYDRUS, which was developed at ARS' George E. Brown, Jr., Salinity Laboratory in Riverside, CA.

Thanks to a cooperative research and development agreement with the Colorado School of Mines' International Ground Water Modeling Center (IGWMC) in Golden, the model continues to evolve. IGWMC distributes the model, provides hands-on help to users, runs short courses on the model, and gives feedback to ARS so the researchers can improve HYDRUS.

So far, IGWMC has sold more than 500 copies of the model worldwide.

HYDRUS is an easy-to-use, Windows-based format. It displays results visually by means of graphs or contour lines, instead of as columns of numbers. Animation can illustrate how a fertilizer or other chemical would move through the soil and possibly into groundwater.

Soil Physics and Pesticide Research Unit, Salinity Laboratory, Riverside, CA
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Designing rock chutes has been made easier–with fewer design errors–thanks to a new computer program.

Rock chutes are loose rock structures built at water resource construction sites to safely convey water to lower elevations.

Natural Resources Conservation Service engineers are using a computerized design procedure developed by ARS researchers. It helps them to more quickly and accurately predict the best design for a given chute size and flow rate.

Intended for use with Excel in Microsoft Office 97, the program addresses many additional features needed to design low-cost, environmentally sensitive hydraulic structures. For example, the program can calculate the amount of rock necessary to construct the chute and provide a cost estimate. It should accelerate the application of rock chute technology.

A free copy of the program can be downloaded at the web address. Go to http://www.ia.nrcs.usda.gov/design> and link to Engineering Programs. It is listed under the name "Rock Chute Design Program." This design tool should be useful to consulting engineers and water resource managers.

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Quarterly Report

of Selected Research Projects

USDA United States Department of Agriculture
ars Agricultural Research Service

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Contact the scientists listed for further information on each research project. For general questions about this report, contact Linda McElreath, ARS Information, 5601 Sunnyside Avenue, Beltsville, MD 20705, (301) 504-1658, lmcelreath@.ars.usda.gov

Items marked with the word PATENT are being patented by ARS. For more information on patents, CRADAs and patent licenses, contact ARS Office of Technology Transfer, 5601 Sunnyside Avenue, Beltsville, MD 20705-5131. Questions about a company's product and/or research should be directed to the company itself.

This publication is available on the World Wide Web at http://www.ars.usda.gov/is/

Into the Marketplace

Antibodies developed by ARS scientists may lead to a test to help poultry producers protect chickens against a major chicken disease, while reducing the potential for antibiotic residues in poultry.

Each year, coccidiosis costs U.S. poultry producers an estimated $600 million in treatment and low carcass weights. Nicarbazin, a pharmacological agent that controls coccidiosis, is usually added to chicken feed.Nearly all commercial poultry feed contains some type of medication.

The problem: No method exists to monitor the levels of the antibiotic in feed. So producers could be paying for feed that may not contain enough nicarbazin to protect the birds, or too much of the drug may result in nicarbazin residues in meat products.

International Diagnostic Systems (IDS) Corporation in St. Joseph, MI, is using the antibodies in a laboratory enzyme-linked immunosorbent assay (ELISA) kit. An ELISA kit could be ready for use by the quality control departments of feed manufacturers by the spring of 2001.

ARS has applied for a patent on the antibodies, which were developed under a cooperative research and development agreement with IDS. Such a test could also help USDA Food Safety and Inspection Service officials be sure that producers have complied with federal Food and Drug Administration regulations preventing residues in meats.

Food and Feed Safety Research, College Station, TX
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Fantesk, a mixture of starch, water, and oil made by an ARS-patented process, is now being marketed as a seed coating.

Development of other new agricultural, food, industrial, medical, and cosmetic products may not be far behind, considering the high level of commercial interest in the product. The first commercialization of Fantesk was rooted in a 1994 cooperative research and development agreement (CRADA) between ARS and Seedbiotics, Inc., of Caldwell, ID, a company that obtained an exclusive license for seed-coating applications and later independently developed specific product formulations.

Under one of the latest agreements with ARS, Azure Waves Seafood, Inc., Cincinnati, OH, is developing seafoods seasoned with herbs and spices in Fantesk breading. Other food applications on the horizon include

cheeses with less than 3 percent fat, soft-serve ice cream with about 1.1 percent fat, and cookies and muffins with fewer fat calories than typical baked goods.

ARS scientists are producing 1,000-gallon lots of Fantesk that a new CRADA partner, Hy-Gene Biomedical Corporation, Ventura, CA, needs for research. Hy-Gene holds an exclusive license for all topical therapeutics and drug delivery, as well as skin- and wound-care medical applications.

Working under a CRADA with Shrieve Chemical Products, Inc., Woodlands, TX, ARS scientists invented a way to use a Fantesk formulation as a water-based, drilling-mud additive to reduce drill bit wear.

Fantesk is a versatile material, formed first as a gel when starch and an oil, such as soy oil, are processed in pressurized steam. Whether the gel is melted into a liquid, frozen and then thawed, or drum-dried into a solid, flaky material and then milled into a powder and redispersed in water, 0.1- to 10-micron-diameter droplets of oil remain well distributed in the starch with no greasy feel.

National Center for Agricultural Utilization Research, Peoria, IL
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Although they have different end uses, red and white wheat varieties look very similar. So ARS researchers helped standardize an old test and made it reliable enough to consistently distinguish red from white wheat.

It's an important advance for export markets, because baking and milling characteristics of hard red and white wheat varieties differ. Wet weather and other environmental factors can add to the difficulty. For instance, red wheat that's been rained on can look white.

Red wheats are typically used for baking breads, but white wheats are used to produce bright-yellow noodles for Asian consumers.

The new test uses a dilute sodium hydroxide solution to accentuate color differences between the reds and the whites.

Perten Instruments in Springfield, IL, has already turned the test into a kit. With it, grain elevator operators can determine correct color class in as little as 10 minutes and at a cost of only pennies per sample. Several grain elevator managers in Kansas used the kit during the 2000 winter wheat harvest season, and more elevator operators in Oklahoma and Nebraska have indicated they may use it during the 2001 harvest season.

This project was funded by the Kansas Wheat Commission and administered through the Grain Industry Alliance under a cooperative research and development agreement. The research may help expand export markets for hard white wheat, which is becoming more popular with Great Plains wheat farmers.

Grain Marketing and Production Research Center, Manhattan, KS
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Cooperative Research and Development Agreements

...With The Rice Foundation, Houston, TX, to determine whether changing the way rice bran is processed may make bran's healthful compounds—such as fiber and antioxidants—more available for the body to absorb and use.

Bran is the nutritious, light-brown layer covering the white rice kernel. Using a standard piece of food-processing equipment known as an extruder, scientists are making adjustments in the amount of time, mechanical energy, and heat used to process the bran.

The researchers are collaborating with scientists from the University of California, Davis, Medical Center. In earlier studies, the ARS-UC Davis team showed that laboratory rats fed extruder-processed wheat bran had a lower incidence of a colon cancer indicator— aberrant crypt foci (ACF)—than rats fed raw wheat bran. The animals were injected with a compound that stimulates ACF formation. The new rice bran research will include similar ACF tests.

Western Regional Research Center, Cereal Product Utilization Research Unit, Albany, CA
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...With Scenturion, Inc., Clinton, WA, to develop dispensers for a new, ARS-developed lure for cutworms, armyworms, and fruitworms.

The bertha armyworm, spotted cutworm (*Lacanobia* fruitworm), and true armyworm attack potatoes, corn, flax, canola, apples, and numerous vegetables. Recent losses of apples from the fruitworm have been as high as 25 percent in some orchards.

The new lure is the first to attract females of these pests (Patent Application No. 09/156,348). It will help growers more accurately predict when to use pesticides or other control measures to directly eliminate the egg-laying females. Other integrated pest management techniques have relied on sex pheromones produced by the females to attract male moths.

The lure consists of acetic acid and one or more alcohols. When mixed, the compound produces a vapor attractive to the moths.

Under the CRADA, the team will also develop insecticide-loaded traps that use the lure to attract the moths and then kill trapped females. The team hopes to have the first commercial product available within 2 years.

Yakima Agricultural Research Laboratory, Wapato, WA
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Soil, Water, and Air Quality

Hard soils that restrict root growth and reduce crop yields in the southeastern coastal plains can be overcome if producers use specialized deep tillage to loosen the soil.

But on a per-acre basis, deep tilling costs an extra 2.5 gallons of fuel, adds a quarter hour of labor, and requires a large, 200-horsepower tractor. To help producers make well-informed decisions on whether to deep till, ARS and Clemson University researchers linked knowledge of soil hardness at planting to potential yield losses.

To predict yield loss for intensively managed corn and soybeans, the study combined data on soil strength measurements at the beginning of the growing season with rainfall amounts at critical times in plant growth. It included treatments that either had not been deep tilled or had been deep tilled from 1 day to 3 years before planting.

For Rains sandy loam soil, predicted yield losses ranged from 20 to 50 bushels per acre of corn and 16 to 26 bushels per acre of soybeans for each 10-atmosphere increase in soil strength. An atmosphere is 14.7 pounds of pressure per square inch of soil.

Coastal Plains Soil, Water, and Plant Research Center, Florence, SC
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Reducing sediment-laden runoff and improving water clarity have revitalized two Mississippi freshwater lakes as good sports fisheries.

The increased water clarity boosted plankton growth, necessary to support bass populations that were lacking before the renovation and restocking.

Natural oxbow lakes of the Mississippi Delta, long known for their productivity and recreational value, have declined in popularity because of poor water quality and reduced plankton growth. Research shows that cultural best management practices (BMPs) on nearby farms—in addition to structural measures—may be needed to improve fisheries in these lakes that were formed by meandering rivers and protected by nearby watersheds.

Scientists were able to successfully reintroduce sports fish in the two lakes whose watersheds were protected with both culture-based BMPs—like conservation tillage and cover crops—and structural BMPs. The latter included grade stabilization structures like tall fescue grass filter strips and riparian forest buffer zones to reduce waterflow speeds. But structural BMPs used alone on the third lake didn't improve water quality enough to elicit an ecological change.

National Sedimentation Laboratory, Oxford, MS
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An ARS-developed portable rainfall simulator (PRS) is helping scientists establish soil phosphorus threshold levels as local, state, and federal agencies gear up to curb the nutrient's runoff into rivers, lakes, and other water systems.

In fresh waters, excessive phosphorus causes eutrophication, which triggers massive algal blooms whose subsequent decay can deprive aquatic life of oxygen.

Ultimately, this impairs the quality of that water for drinking and recreation.

Scientists are using the PRS to study how runoff carries phosphorus from crop fields, particularly when phosphorus-rich manure has been applied at levels exceeding the amount that the soil or plants can retain.

The PRS involves pumping water from a tank on a customized trailer or pickup into a spray nozzle attached to a 10-square-foot aluminum frame. The nozzle uniformly showers the underlying soil at a controlled rate until runoff occurs for collection, weighing, and analysis.

As soil phosphorus increases, for example, PRS data has shown there is a threshold soil level above which potential for the nutrient's loss in runoff dramatically increases.

Starting in the spring of 2001, scientists participating on the ARS-led National Phosphorus Research Project will use nearly two dozen PRS devices to standardize their collection of runoff data. This will take place on up to 50 different soil types at 20 research locations across the country. A key objective is establishing phosphorus management guidelines that simultaneously protect the environment and meet farmers' needs.

Watershed and Pasture Systems Management Research Laboratory, University Park, PA
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The amount of soluble cadmium (Cd) in soil can be predicted, based on soil pH and total Cd content.

That's the finding of a Cornell University-Ithaca/ARS study of 64 soils collected from U.S. and Canadian fields with and without known Cd contamination.

The purpose of the study was to understand which, if any, soil properties (like pH, soluble and total organic matter) affect the solubility of Cd in soils.

A naturally occurring trace element, cadmium is found throughout the environment. It is a potentially toxic heavy metal with no known requirement by living organisms. It is most readily taken up by plants in its soluble form as it is drawn in through the roots and deposited in edible portions like stems and leaves. In animals, Cd accumulates mainly in the kidney and liver. At high levels, it can reach a critical threshold and lead to serious kidney failure.

Many human activities—like land applications of sewage sludge, industrial sludge, manure, or phosphate fertilizer—increase soil Cd and can sometimes cause contamination.

In the 64 soils studied, the amount of soluble Cd ranged more than a thousandfold, from 0.03 to 182 micrograms per liter. The solution pH, which ranged from 3.5 to 8.1, was the main determining factor—along with total Cd content—controlling solubility.

U.S. Plant, Soil, and Nutrition Laboratory, Ithaca, NY
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Linking irrigation to crop temperature can improve the efficiency and profitability of water use, thus optimizing crop yields and conserving natural resources.

High crop temperature—a good indicator of crop water stress—can be measured accurately within each area of a field using noncontact infrared thermometers (IRT) on center-pivot irrigation machines. Commercial IRTs are inexpensive and easy to use, making them an attractive alternative to costly, research-grade sensors.

ARS scientists spaced 26 IRTs along a center-pivot system modified to apply

irrigation water on 396 plots, each about 30 feet square. Some plots were well irrigated, while others were left dry.

Soil temperature differences of up to 14 degrees between irrigated and dry plots were easily detected with the IRT array. Surprisingly, the same treatments on multiple plots of the same soil type showed temperature variations of as much as 6 degrees. So water stress caused by elevated soil temperature can vary, even across a single soil type. This shows the importance of adjusting for variation in crop water stress while managing irrigation.

Applying the correct amount of water only when a plant's temperature indicates it's needed makes possible a more effective stewardship of the nation's scarce water resources.

Coastal Plains Soil, Water, and Plant Research Center, Florence, SC
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Best management practices (BMPs) keep pesticides from contaminating groundwater in the Mississippi Delta.

Spearheaded by ARS scientists, the Mississippi Delta Management Systems Evaluation (MSEA) Project develops farming systems based on economical and environmentally sound BMPs. The project encourages implementation of many BMPs designed to slow surface water runoff and enhance the soil's processing and retention of farm chemicals.

Such practices tend to increase water infiltration and reduce the potential for farm chemicals to leach into the soil, possibly harming groundwater quality, or seeping into relatively shallow water tables with subsurface connections to nearby bodies of water.

From 1996 to 1998, ARS scientists collected groundwater samples from 622 shallow wells in the 7,000-square-mile Mississippi Delta MSEA area. They placed groundwater sampling wells in riparian zones along rivers and streams, as well as in corn, cotton, soybean, and rice fields.

Analyses of water samples showed only five pesticide detections. All were at very low levels—0.4 to 8 parts per billion. This confirmed that BMPs allow soil to slow down and process pesticides in upper layers, greatly reducing their below-ground seepage.

The finding clears the way for further establishing the BMPs on a regional scale, with good probability of their adoption by farmers and landowners.

National Sedimentation Laboratory, Oxford, MS
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An intensive search for fumigants that can rid strawberry fields of soil-dwelling pests has revealed several promising compounds.

They are needed as alternatives to methyl bromide, the widely used fumigant that is being phased out because it depletes the Earth's protective ozone layer.

ARS scientists in California found that marketable yields of strawberries from some plots treated with a fumigant called InLine were from 95 to 110 percent of those from plots treated with methyl bromide.

InLine is a combination of about 60 percent 1,3-dichloropropene and up to 35 percent chloropicrin, a chemical typically used in combination with methyl bromide.

Delivered to fields in irrigation system lines known as drip tapes, InLine is the water-soluble version of Telone C35, a compound already approved for use—with certain restrictions—to disinfest strawberry fields before planting.

Plots treated with chloropicrin alone, applied at the same rates as InLine, resulted in about the same yields.

Typically, fumigants are pumped into the soil as a gas. Using drip-irrigation systems may reduce worker exposure to the chemicals and may also decrease the amount of fumigant needed.

Water Management Research Laboratory, Fresno, CA
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How much herbicide or fertilizer runs off farm fields to pollute streams and rivers may depend less on the amount of chemicals applied and more on other factors such as the properties of the chemicals applied, soil characteristics, farming systems, and how soon it rains after chemicals are applied.

In a 5-year study on claypan soils in the Midwest, which are representative of 10 million acres in the United States, ARS scientists found that heavy rains soon after fertilizer application may pose the greatest risk for nitrogen losses from soil in the forms of nitrate and ammonium. Fertilizer was also more apt to run off when it was spread evenly and incorporated into the soil by tilling than when it was knifed into the soil surface in narrow bands.

The herbicides atrazine and alachlor were more prone to runoff losses in a no-till farming system than when they were incorporated in a minimum-tillage system.

In a study in northern Missouri watershed basins, scientists found that the properties of the agricultural chemical applied and the soil characteristics of the watershed were more important to water quality of streams than the amount of chemical applied. In watersheds with well-drained soils but high row-cropping intensity, herbicide concentrations were much lower in stream water than in watersheds with low to moderate row-cropping intensity and poor drainage.

The effects were opposite for nitrate contamination of streams, with the highest contamination in watersheds with well-drained soils and high row-cropping intensity.

Nitrate concentrations were higher because farmers in such watersheds have historically applied more nitrogen fertilizer, and because more of the stream flow in these watersheds originates from nitrate-contaminated groundwater.

The information from these studies can help develop better management practices for specific farming regions to maximize the potential for water quality improvements.

Cropping Systems and Water Quality, Columbia, MO
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Peach growers might be able to cut back the amount of water and fertilizer they use, yet still produce plump, perfect peaches.

A long-term, ARS-led study may help California peach growers save water and avoid leaching of excess fertilizer into the underground water supply.

ARS scientists and their university colleagues are experimenting with the timing and amount of water and fertilizer that they apply to about 1,800 young peach trees in a research orchard at Parlier, CA. The study features young trees because very little is known about their exact needs for water and nutrients such as nitrogen, phosphorus, and potassium.

The researchers are looking for differences in growth that result from delivering varying quantities of water and fertilizer through furrows, microjet sprayers, or drip-irrigation tubing.

The scientists are monitoring data from more than 500 probes and sensors positioned in the orchard. And they're using a miniature video camera to spy on root growth.

Findings should apply not only to peaches, but also to orchards of other stone fruits, including nectarines, apricots, and plums. California produces more of these crops than any other state.

Water Management Research Laboratory, Fresno, CA
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With proper nitrogen fertilization and a no-till production system, Great Plains dryland farmers can grow crops continuously, reduce erosion, and improve the soil's ability to store carbon, ARS scientists found.

Typically, farmers in the Great Plains grow rain-fed grain crops like wheat, corn, or barley one year and leave the land fallow the next.

With conventional tillage, the fallow period is needed to allow enough water to accumulate in the soil to support the next crop.

But this practice increases wind erosion of the soil and speeds decomposition of plant material, a process that releases carbon dioxide to the atmosphere.

Researchers have long known that no-till, or planting directly into the previous year's crop residue without tilling, reduces erosion and makes more efficient use of water.

They've also found that no-till enhances the soil's ability to store carbon, which helps mitigate global change by reducing the amount of carbon dioxide reaching the atmosphere.

Now, ARS research has shown that nitrogen may mean the difference between economic success and failure when using no-till on the Great Plains. In several no-till studies lasting from 9 to 12 years, adding sufficient nitrogen fertilizer increased grain yields and improved water use enough to make continuous cropping feasible. The added nitrogen also increased the amount of plant material left as crop residue. Over time, the nitrogen/no-till combination led to increased soil organic carbon and improved soil quality.

Soil-Plant-Nutrient Research Unit, Ft. Collins, CO
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Food Safety and Quality

In a ground-breaking study, ARS scientists screened broccoli varieties to see if they induce activity of a key enzyme in the human body that may protect against certain cancers.

Working with researchers at Johns Hopkins University's School of Medicine, Baltimore, MD, the scientists evaluated a diverse collection of broccoli (*Brassica oleracea*) varieties for their ability to stimulate what's called a "mammalian detoxification enzyme," which helps protect mammals–including humans—against development of cancer.

In 1996 and 1997, the scientists grew 71 USDA broccoli varieties and 5 commercial hybrids in the field and took extracts from each. The team looked for a chemoprotective compound called glucoraphanin in the extracts. A derivative of glucoraphanin spurs mammals to activate detoxification enzymes.

Broccoli florets and young seedlings are rich sources of glucoraphanin and its breakdown product, sulforaphane, which is a potent inducer of mammalian detoxification enzyme activity and inhibits early tumor growth in rodent models.

The scientists found a 30-fold variation in glucoraphanin content and enzyme activity among the broccoli varieties tested.

Breeders may be able to exploit such variation to develop new broccoli varieties with greater levels of the protective compounds.

U.S. Vegetable Laboratory, Charleston, SC
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When cooking ground beef, relying on color to determine doneness may be a mistake, according to ARS researchers.

They made this finding while testing a summer ritual: cooking burgers on a gas grill. As expected, the longer the burger was cooked, the less pink the center portion.

But burgers removed from the grill with pink centers continued to brown for several minutes. Ground beef cooked to 135 degrees F

and allowed to sit for about 4 minutes looked the same as a burger cooked to 160 F.

Burgers with a brown center are not necessarily safe to eat. Premature browning was not evident in frozen patties that were thawed and then cooked. But beef frozen in bulk, thawed, formed into patties, and immediately cooked showed brown color at unsafe temperatures.

Only 5 percent of consumers use a meat thermometer during cooking. Most rely on color as an indicator of when meat is done. The temperature at which *E. coli* is killed, 160 dgrees F, is considered the threshold for safe consumption of ground beef.

Food Technology and Safety Lab, Beltsville, MD
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The Hydrodynamic Pressure (HDP) Process–known to make whole-muscle meats more tender–may also reduce foodborne pathogens like *Escherichia coli*, ARS researchers report.

E. coli and other pathogens can live and grow on meat and cause foodborne illness if the meat is improperly handled and eaten. In conducting tenderizing experiments with HDP, an added benefit arose—treated meats seemed to have less bacteria on the surface of the meat than before.

Scientists already proved that HDP penetrated throughout whole cuts of meat, making them more tender. At that point, they wanted to see if bacteria were reduced throughout ground meats as well.

Ground meat samples examined immediately after HDP treatment showed reduced levels of shelf-life bacteria. Additional studies showed HDP-treated ground beef, seeded with *E.coli* 0157:H7 before treatment, had no detectable levels of the organism afterward.

While these bacterial reductions are encouraging, further studies are necessary to determine if HDP can be commercially viable for microbial supression.

Food Technology and Safety Laboratory, Beltsville, MD
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Dioxins, a family of chlorinated compounds which includes some that are highly toxic, can be detected in concentrations as low as 0.1 parts per trillion in fat samples.

New, cost-saving technologies that ARS scientists developed to detect the dioxins can help provide assurance that food produced, consumed, or exported is safe.

When the researchers began dioxin research in 1994, analysis cost nearly $2,000 per sample. Even though it's now down to about $600 to $800 per sample, the scientists are developing an even more efficient procedure—an immunoaffinity column method—which requires minimal use of chemical solvents and is expected to reduce present analysis costs by half.

Dioxins, produced by natural or industrial processes, are chlorinated aromatic compounds that can build up in the fat of humans and animals and may increase the risk of tumors and possibly other undesirable health effects.

In a mid-1990s study on the extent of dioxin contamination in livestock, the scientists researched dioxin levels in beef produced in 13 states. They found that, with some outstanding exceptions in the kidney fat of some individual carcasses, samples were generally "clean."

Now, USDA's Food Safety Inspection Service is again surveying meats for dioxin contamination to get a better picture of the background levels in the U.S. food supply. ARS scientists are researching ways to minimize the burden of dioxin compounds that persist in the animals' bodies.

Animal Metabolism-Agricultural Chemicals Research, Fargo, ND
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Honeydew aficionados gave a higher thumbs-up to fresh, ripe honeydew melons if they were dunked whole into a

calcium solution before going into commercial storage for up to 3 weeks.

ARS consumer preference panelists evaluated cut melon cubes for appearance, texture, and taste. Earlier research had shown the new handling procedure prolonged the market life of ripe melons up to 2 weeks beyond the normal shelf life of 7 to 12 days.

The soaking supplied extra calcium that, in ripe melons, steadily migrates from the rind to the seeds. Rinds need calcium to maintain a degree of firmness that protects against spoilage. Even before the latest findings, growers and melon marketers were taking interest in the treatment to prolong shelf life and maintain quality.

Now, Albion Laboratories, Inc., Clearfield, UT, a manufacturer and exporter of dietary supplements, vitamins, and minerals, is planning to expand production of amino acid-calcium chelate to help meet new worldwide demand for melons. The company has entered into a 1-year cooperative research and development agreement with ARS to study treatments of honeydews and cantaloupes still on the vine as a supplement or alternative to postharvest treatments.

Per capita melon consumption in the U.S. reached new highs in the 1990s, thanks largely to sweeter, more nutritious varieties. The calcium treatment may further boost melon consumption by paving the way for extensive domestic and export marketing of vine-ripened fruit.

Crop Quality and Fruit Insect Research, Weslaco, TX
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More phytosterols–plant compounds associated with lowering cholesterol in humans—can be extracted from corn fiber and bran oil using an ARS-refined processing method.

ARS researchers joined two environmentally friendly processing techniques, supercritical fluid extraction (SFE) and supercritical fluid fractionation (SFF), in laboratory studies that yielded up to 11 times more phytosterols from corn bran oil and 2.3 times more from corn fiber oil.

Phytosterols and other "nutraceuticals," as they are also called, occur in low levels in plants. The researchers increased the amount of phytosterols from 1.3 to 14.5 percent per 100 grams of corn bran. Applying the extraction methods to corn fiber increased yield of phytosterols from 23 percent to 53 percent.

Other ARS scientists have recently shown that ferulate phytosterol esters (FPE), which are compounds in corn bran, can lower cholesterol in humans. Commercial products containing FPEs include margarine spreads.

Using "green" processing to provide alternative sources of phytosterols will also enhance agriculture by increasing value-added uses for by-products of the oilseed and milling industries. Other plant sources of important phytosterols include rice bran and soybeans.

National Center for Agricultural Utilization Research, Peoria, IL
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Edible films made from pureed produce can add shelf life, flavor, and nutrition to food products.

Use of fruits and vegetables can also be increased through this technology.

ARS researchers developed the films from produce such as apples, oranges, carrots, and strawberries. The thin, opaque films can be applied to everything from sliced apples to cuts of meat.

In laboratory experiments, the films controlled browning and prevented moisture loss better than several other types of coatings. The films could also provide new flavor combinations, such as a strawberry film on cut bananas or an apple glaze on pork.

Sheets containing pureed fruit have long been available as snack foods. But this is the first time thin sheets of up to 100 percent fruit or vegetable material have been tested to enhance storage and flavor.

ARS has applied for a patent on the edible films (Application No. 09/330,365).

Process Chemistry and Engineering Research Unit, Albany, CA
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ARS researchers are closer to providing industry with tools to develop a delicious, vine-ripened tomato that survives a week of shipping and handling and still remains firm on the kitchen counter for another week or more.

They have identified new genes involved in turning a firm tomato into mush. In the process, they produced vine-ripened tomatoes that were 40 percent firmer than unmodified siblings and stayed firmer for at least 2 weeks.

The plants were engineered with a reversed gene for an enzyme that removes a sugar from cell walls. The reversed gene actually blocks removal of the sugar galactose, thus helping to keep the tomato's cell walls firm.

Those firm tomatoes support the theory that loss of galactose plays a key role in the loss of structural integrity of cell walls. Structurally sound cell walls are essential to tomato firmness.

The researchers focused on galactose because it's the sugar that changes most throughout fruit development. They actually identified and sequenced seven different genes that code for the galactose-removing enzyme, called beta galactosidase.

They have inserted five of those genes into the tomato genome but have so far tested tomatoes with only one of the reversed, or antisense, genes—number 4. U.S. and international patent applications on all seven genes has been filed for ARS.

With growing competition in today's fresh tomato market—worth nearly $1 billion in 1999—the time may be ripening for a tasty tomato that ages gracefully.

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Animal Production and Protection

A new catfish variety bred by ARS scientists—USDA 103—was made available to catfish producers in February 2001.

The new, higher performing catfish should have a significant effect on commercial production in the major catfish-producing states—Alabama, Arkansas, Louisiana, and Mississippi.

It usually takes catfish 18 to 24 months to grow from birth to market size. This new variety grows 10 to 20 percent faster and is ready for market sooner than other varieties.

USDA 103 consumes 10 to 20 percent more feed than other catfish. However, the feed costs only 10 cents per pound and producers can often get 70 to 80 cents per pound for the fish.

The new catfish also has different reproductive characteristics. Some USDA 103 catfish can reach sexual maturity at 2 years of age—a year faster than current catfish. They also start producing eggs sooner and produce more of them than some fish now raised commercially.

ARS released the new catfish jointly from the Thad Cochran National Warmwater Aquaculture Center with the Mississippi State University Agricultural and Forestry Experiment Station, Mississippi State, MS.

Catfish Genetics Research Unit, Stoneville, MS
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A new vaccine against the most stubborn cases of mastitis—those caused by *Staphylococcus aureus* bacteria—is showing promise.

The vaccine could catch the 50 to 60 percent of staph-caused mastitis cases in the United States that have eluded today's commercial vaccines.

An ARS dairy scientist developed the vaccine with the biotechnology company Nabi in Rockville, MD.

Large-scale tests to confirm the vaccine's ability to prevent infection have not yet been done. But it is proving effective at curing intractable mastitis cases when combined with antibiotics, according to studies by a Michigan State University veterinary scientist.

Antibiotics are often ineffective against staph because the bacteria have become resistant or are holed up in places the drugs can't reach.

The new vaccine proved as effective as a herd-specific vaccine developed by the MSU veterinarian, curing 55 to 60 percent of infected cows. And it cleared staph infections in about 10 percent of infected cows in his study, even before antibiotics were administered.

ARS is now looking for a agricultural partner to fund further testing and develop a commercial vaccine.

Immunology and Disease Resistance Laboratory, Beltsville, MD
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More than 80,000 DNA gene segments, called expressed sequence tags (ESTs), from cattle and 40,000 from swine have been deciphered by ARS scientists.

The program involved producing "libraries" of gene sequences whose expression ultimately results in synthesis of proteins in tissue cells such as muscle, ovary, and hormone-producing glands that affect production traits.

The EST sequence information is accessible through databases at the ARS U.S. Meat Animal Research Center (MARC), Clay Center, NB. It also was deposited in the national sequence database at the National Center for Biotechnology Information (NCBI). Researchers worldwide can access the NCBI data for research in medicine and animal science.

Researchers at MARC have already been contacted by more than 40 scientists from 9 different countries to make use of the data, with most of the requests coming from biomedical researchers.

ARS scientists and genomics companies are also working together under various agreements to develop technologies such as microarrays, also called gene chips, that help identify genes which control traits important to animal health or production efficiency.

These studies are expected to one day provide a means to increase production values in livestock herds by increasing the accuracy and speed of selection for specific characteristics. They are also likely to lead to new feed additives or nutritional and management strategies to increase efficiency of production.

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Human Nutrition

Blueberries, cranberries, and huckleberries—like dark-skinned bunch grapes—contain resveratrol, a potential anticancer agent. That's a new finding from preliminary data from ARS collaborative studies with Rutgers University-New Jersey and AgCanada, Kentville, Nova Scotia.

Resveratrol protects dark-skinned bunch grapes from fungal diseases and provides health benefits to consumers, including protection from cardiovascular disease. The compound's anticancer potential warranted its examination in other fruits.

Using gas chromatographic and mass spectrometric procedures, the scientists measured the resveratrol content of 30 whole fruit samples of blueberry, cranberry, huckleberry, and related plants representing 5 families and 10 species of

Vaccinium fruit. They found that several samples contained varying amounts of the compound.

Analysis of extracts of the skin, juice/pulp, and seed of muscadine grapes showed that its concentration in fruit skin was highest. Levels in the juice/pulp were much lower than in either skin or seeds.

Researchers are continuing to analyze more *Vaccinium* and muscadine samples. Future research goals will include enhancing production of resveratrol in selected species.

Natural Products Utilization Research Unit, Oxford, MS
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The essential mineral molybdenum may be easier for your body to obtain from some foods than others, but little is known about differences in bioavailability.

Now an ARS study of soy and kale has provided new information about the molybdenum in these foods.

The findings can be taken into account when updating national guidelines for suggested daily intake of this nutrient.

ARS scientists in Davis, CA, collaborated with university researchers in Indiana and Korea for the molybdenum experiment. They used soy and kale plants grown in buckets of liquid nutrients, including two easily detectable forms of molybdenum called stable isotopes. Volunteers—12 healthy young women and 11 healthy young men—ate meals that contained the soy or kale added as puree to noodle casseroles.

The molybdenum in soy was significantly less biologically available than the molybdenum in kale, according to analyses of fecal samples.

Molybdenum is a key component of several critical enzymes. Most Americans get enough molybdenum because a variety of foods provide it, including pumpkin and sunflower seeds, peas, beans, peanuts and other legumes, and grain-based products such as breakfast cereals or whole-grain breads.

Western Human Nutrition Research Center, Davis, CA
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A new study of selenium, a nutrient essential for good health, will explore some of the potential side effects of this mineral. The ARS-led investigation will provide new information about selenium, which has been shown in preliminary studies elsewhere to help fight lung, prostate, and colon cancer.

Scientists will work for 2 years with about 50 volunteers—healthy, nonsmoking men age 18 to 45. Tests will determine whether selenium supplements—like the kind sold in drugstores or supermarkets—cause weight gains.

The research will also indicate whether the supplements temporarily lower sperm motility, which might reduce a man's ability to father children during the time he is taking the mineral.

Weight gains may benefit people with cancer, AIDS, or other "wasting" diseases.

Scientists with the ARS Western Human Nutrition Research Center in Davis, CA, are conducting the experiment in collaboration with physicians from the University of California, San Francisco, Department of Urology, and the University of California, Davis, Medical Center, Department of Cardiovascular Medicine.

Western Human Nutrition Research Center, Davis, CA
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A fast, gentle procedure called Bioimpedance Spectroscopy, or BIS, may help physicians monitor treatments designed to stop muscle loss, also called "wasting."

ARS nutrition researchers in California have pioneered the use of BIS with healthy volunteers to measure body composition—that is, the amount of fat and lean tissue, including muscle, in our bodies. Fat-to-lean ratios are regarded as one of the best indicators of our health and are directly influenced by eating and exercise.

In a study led by researchers from the University of California's San Francisco and Berkeley campuses, ARS scientists showed that BIS can be used to gauge whether specific medication and exercise regimens stop muscle loss in AIDS patients.

BIS was just as accurate but faster, easier, and less costly than two other approaches—DEXA, or dual-energy X-ray absorptiometry, and deuterium oxide dilution. The findings suggest that BIS could also be used to monitor muscle mass in wasting diseases including cancer and tuberculosis.

BIS takes only a few minutes and involves sending a harmless electrical current, at a range of frequencies, from electrodes placed at the wrists and feet of the volunteer.

Western Human Nutrition Research Center, Davis, CA
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An unusual kind of corn developed by an ARS researcher may help ensure that people get more of the zinc that they need for good health.

The unique corn has about 65 percent less phytic acid, also known as phytate, than conventional corn. That's a plus because phytate is thought to interfere with the body's ability to absorb certain nutrients, including zinc, an essential mineral.

Physicians and scientists from the University of Colorado Health Sciences Center in Denver collaborated with an ARS geneticist in the zinc experiment. For the test, five healthy adult volunteers age 23 to 39 ate menus featuring polenta—a cooked, coarse cornmeal—for 2 days. Cornmeal from the low-phytate corn was used to make the polenta one day, and cornmeal from conventional corn was used the next. Both kinds of cornmeal were spiked with rare forms of zinc, known as stable isotopes, that can be easily detected by laboratory instruments.

Analysis of fecal samples showed that the volunteers absorbed about 78 percent more zinc, on average, from the low-phytate corn than from the conventional corn. The Colorado researchers are now using the low-phytate corn in a larger, follow-up study with Guatemalan villagers.

Small Grains and Potato Germplasm Research Unit, Aberdeen, ID
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An experimental bread made of ultrafine-ground whole-wheat flour could help Americans boost their fiber intake—now considerably below the recommended 25 grams daily—and reduce the risk of diabetes in the process.

The flour, developed by ConAgra, gives the bread a taste and texture very similar to white bread. But it has six times more fiber.

ARS researchers wanted to see if the particle size would improve blood glucose and insulin levels on a glucose tolerance test, which indicates a person's potential for diabetes. It did.

The experimental bread improved blood glucose and insulin levels in the 26 volunteers about the same as regular whole-wheat bread.

Volunteers' levels stayed lower on the experimental bread than when they ate white bread or consumed a glucose drink.

According to ConAgra, the new flour has been used in some commercial breads, waffles, and other products for about 5 years. But the market is limited because the flour is made from white wheat, rather than the more plentiful red wheat. The company is working to gear up U.S. production of white wheat so it can market the flour more broadly.

Diet and Human Performance Laboratory, Beltsville, MD
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More evidence that vitamin K helps maintain strong bones comes from a new look at data from 888 elderly men and women who participated in the Framingham Heart Study between 1988 and 1995.

The study, led by a nutritionist at the Jean Mayer USDA Human Nutrition Research Center on Aging in

Boston, also involved researchers from the Hebrew Rehabilitation Center for Aged and Training Institute, Harvard Medical School, and other institutions.

Men and women who reported the lowest daily vitamin K intakes—averaging 56 micrograms—in 1988 experienced significantly more hip fractures by the 1995 examination than those reporting the highest intakes, averaging 254 micrograms. That's close to four times the Recommended Dietary Allowance, now set at 65 to 80 micrograms for women and men, respectively.

Dark-green leafy vegetables, like spinach and broccoli, are rich in vitamin K, known chemically as phylloquinone. One serving of spinach or two servings of broccoli provide four to five times the RDA.

The new findings support others reported in 1999. Analysis of data from more than 72,000 women in the Nurses' Health Study showed that low vitamin K intakes increased risk of hip fracture.

Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University, Boston, MA
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Crop Productivity

An ARS-led team had a key role in the newly completed, history-making venture that deciphed the structure of all genes in a little mustard family plant, *Arabidopsis thaliana.* The Albany, CA, team helped determine the structure, or sequence, of the genes on the largest of the five *Arabidopsis* chromosomes.

The worldwide *Arabidopsis* project yielded the first complete, publicly available catalog of the structure of all genes that come into play in the life of a flowering plant, from seed to flower to fruit.

Now, the Albany team and other researchers are working to discover the function of each of the *Arabidopsis* genes. If the scientists determine, for example, what genes control resistance to insects or diseases, they might then be able to shuttle these genes into plants that lack natural protection. Or the researchers may retool the genes to boost their effectiveness.

Arabidopsis, also known as mouse ear cress or thale cress, has less genetic material than familiar crop plants such as corn or wheat. But discovering the structure and—next—the function of *Arabidopsis* genes helps reveal clues to the form and function of genes in all flowering plants.

ARS/University of California at Berkeley Plant Gene Expression Center, Albany, CA
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Studies of transgenic potatoes show that one cultivar with the *Bacillus thuringiensis (Bt)* gene has lost its resistance to the golden nematode, *Globodera rostochiensis.* This pest can wipe out entire potato crops by feasting on the plants' roots.

So far, these tiny worms have attacked the U.S. potato crop only in New York.

Using bioassay tests, ARS scientists found that the nematode infected and reproduced freely on Atlantic NewLeaf clone 6. This potato variety was produced by introducing the *Bt* gene for golden nematode resistance into the cultivar Atlantic.

But two other clones of Atlantic NewLeaf from different *Bt* transformations with Atlantic maintained their resistance.

DNA analysis of these Atlantic NewLeaf clones showed they contained the marker that indicates the presence of the gene for golden nematode resistance.

This suggests that at some place in the transformation process that produced Atlantic NewLeaf clone 6, the expression of this gene was affected and the effect persisted through prerelease testing.

The scientists presented their findings at the July meeting of the Potato Association of America in Colorado Springs, CO.

Plant, Soil, and Nutrition Laboratory, Ithaca, NY
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Cadet and Jacinto, two new rice varieties with a gene for improved cooked rice texture, entered commercial production this year, thanks to new technology that speeded their development.

The new varieties, which produce rice low in amylose content, are adapted to southern U.S. and European growing regions. Though new variety development normally takes 7 to 10 years, ARS scientists and their colleagues at the Texas Agricultural Experiment Station, College Station, did the job in just 5.

The researchers used a biotechnological process called marker-assisted selection to locate desirable genes in noncommercial varieties and deployed them into the new varieties through conventional breeding.

Rice Research, Beaumont, TX
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Light reflected from colored mulches increases the size, aroma, and flavor of sweet basil leaves.

Sweet basil (*Ocimum basilicum* L.) is a high-value specialty crop that is used fresh as an herb or as a dried spice to add a distinct aroma and flavor to food.

ARS scientists, who pioneered the use of colored plastic mulches, found that two components of reflected light enhance plant growth: a low percentage of blue light and a high ratio of far-red to red light. Red plastic mulch reflects onto plants higher amounts of certain growth-enhancing wavelengths of sunlight.

Basil is grown commercially and by many home gardeners outdoors in full sunlight over plastic mulches that conserve water, control weeds, and keep soil from splashing onto leaves.

By using colors other than the standard black for these soil covers, the scientists were able to keep the benefits attributed to black plastic mulch, yet alter the amounts of blue, red, and far-red light reflected to developing leaves. The color of reflected light acted through the plants' natural growth-regulating system to increase leaf size, aroma, and concentration of soluble phenolics, some of which are important antioxidants.

The study was reported in the March issue of the *Journal of Agricultural and Food Chemistry.*

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A study now in progress should help farmers determine which variables limit yields and whether precision agriculture techniques could improve profitability.

Typical scientific research takes place on small field plots, with researchers modifying one or two variables and extrapolating results to the real world.

Now, in a 5-year study of a complete agricultural system, ARS scientists are measuring all possible environmental conditions and farming practices that could affect yield on two commercial farms in Colorado. Their goal: to find the most significant yield determinants.

They're scrutinizing inputs like water, fertilizer, and pesticides to see if intensive management practices—like variable-rate application—benefit the environment and are financially feasible for the farmer. So far, about halfway through the study, researchers have found that farmers were overwatering with their center-pivot irrigation systems. Now the farmers apply less water.

Colorado State University, several state and federal agencies, and six private companies are participating in the research. The multidisciplinary team plans

to develop a decision-support tool based on project results to help farmers decide whether precision farming would be beneficial.

It's also analyzing techniques that measure large field areas economically—such as remote sensing—in order to reduce the cost of precision farming.

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Growers may have problems growing canola on land previously used to raise cotton.

Louisiana producers recently became aware of this because they wanted to use canola (*Brassica napus* L.) as a rotation crop on well-drained soils where cotton (*Gossypium hirsutum* L.) is normally planted. But a common contact herbicide used in cotton production contains arsenic, and crop plants have varying degrees of tolerance to arsenic compounds.

To determine if soil arsenic would influence canola growth, ARS and Louisiana State University scientists conducted a controlled-climate chamber experiment using three soils with histories of cotton production (Commerce, Rilla, and Sterlington silt loams) using three arsenic application rates (0, 5, and 10 milligrams per kilogram of soil).

When arsenic was added to the soil, seedlings grown in the Commerce and Sterlington soils absorbed more of the element than those grown in the Rilla soil, which showed little change.

Arsenic addition had no measurable effect on short-term plant growth. However, arsenic-toxicity symptoms eventually developed on leaves of plants in all treatments where the metal had been applied.

The scientists concluded that the growth of canola plants can be adversely affected by recent application of any arsenic compound.

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Industrial (Nonfood) Products

Corn fiber leftovers from ethanol production can be processed more efficiently into a higher value product called xylitol by making sure glucose doesn't interfere with the transformation process.

Xylitol is a low-calorie sweetener that can cost up to $3 per pound. Currently made from acid-treated fibers of birch wood, it is used in foods, mouthwashes, toothpastes, and chewing gums, where it imparts a minty-cool taste.

But xylitol can also be made from xylose, one of the sugars left over when corn fiber is broken down. A yeast called *Pichia guilliermondii* can convert corn fiber's xylose into xylitol, but that process can be hindered by glucose, another of the leftover sugars from fermented corn fiber.

The problem: When *P. guilliermondii* comes in contact with both glucose and xylose in fermenting corn fiber, it "prefers" the glucose. Like a child who would rather gorge on ice cream than spinach, it spends its energy on gobbling the glucose, which leaves the yeast relatively ineffective in carrying out the xylose-to-xylitol transformation.

The solution devised by ARS scientists: Send in the B team. The scientists add an initial batch of *P. guilliermondii* to the fermenting fibers to devour the glucose. Then they mix in more *P. guilliermondii* to tackle the task of transforming the xylose into xylitol.

Xylitol has one-third fewer calories than conventional sugar and about the same sweetening power. Currently, it commands a $28 million market. Because a biotechnological xylitol manufacturing approach involving corn fiber should require less energy, the scientists envision more research will drive production costs down and market volume up.

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Wheat-gluten-based formulations of any of at least three types of insecticides can be strategically sprayed on plant leaves to control the adult beetle stage of the corn rootworm, instead of larvae.

The new formulations—containing a feeding stimulant and pyrethroids, carbamates, or organophosphates—are effective when applied at about one-tenth the rate of insecticides normally buried in soil to control larvae.

By rotating use of these insecticide types, farmers may help ensure that insecticide-resistant strains of corn rootworms don't quickly develop in their fields. In 1996, ARS patented the use of gluten to help stick sprays to leaves.

Having first extensively researched sprays containing microbial insecticides, the scientists worked under a cooperative research and development agreement with researchers of Trécé Inc. of Salinas, CA, to develop chemical insecticide formulations. Trécé licensed the invention and now markets the formulations under the name CIDETRAK.

The partners have extended the CRADA into 2001 as they test the potential of other insecticides.

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A new, soy-based foam extrusion glue stands ready to give the plywood industry what every industry wants: faster production at lower cost.

To achieve this, ARS researchers used soy flour to replace the animal blood protein in plywood glue. Concerns about a limited supply of animal blood and health issues prompted the search for alternative protein extenders.

Soy flour made the best glue and—at 22 cents per pound—the glue it produces is 50 cents per 100 kilograms cheaper than conventional formulations. The glue mix is made up of 3.5 to 5.5 percent soy flour. It also requires less drying time, uses less water, and produces less waste than conventional plywood glues.

It could create an added domestic market for nearly one-half million bushels of soybeans annually. The United Soybean Board provided funding for this project.

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Crop Diseases and Pests

To detect insects hidden in soil and the interior of plants, ARS scientists and colleagues have adapted acoustic techniques commonly used by engineers to predict mechanical failures.

Traditional field searches for insects are often destructive, time-consuming, and labor-intensive. So researchers have been trying to find a more cost-effective and less destructive way to detect infestations.

The acoustic technique uses sensitive instruments like accelerometers, soil-probe, microphones, and piezoelectric disks to pinpoint insect locations. These sensors convert vibrations into electrical signals.

The portable sensors were found to detect insects within 180 seconds across distances of 10 to 30 centimeters, depending on the soil's composition and peak frequencies of the sound pulses. Those sound pulses were then averaged to create profiles for each insect.

Under laboratory or ideal field conditions—with low levels of low-frequency background noise—insects within 30 cm were detected 100 percent of the time. Under adverse field conditions, the technique was 75 percent reliable.

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ARS scientists will test the effectiveness of combining remotely sensed images with pest-scouting data to develop variable insecticide prescriptions that may do a better job of controlling the tarnished plant bug.

Cotton producers spend $75 million annually to control this pest. The new system uses multispectral imagery to draw a correlation between plant vigor and pest density. It relies on a digital camera, sensitive to different wavelengths of light.

Mounted in an aircraft that flies over cotton fields at various altitudes, the camera records images that can be processed to display variations in plant vigor.

ARS researchers have found that plant bugs are more common in areas with more vigorous plants. This combination system is not only better at locating a variety of pests, but also gives growers a more cost-effective method of controlling the pests by improving the placement and timing of pesticide applications.

Rather than spray an entire field at one rate, this system allows growers to vary their coverage. Unsprayed areas can act as safe havens for a variety of beneficial insects, which can then repopulate the field after spraying. This all translates into less chemical usage.

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Raspberry plants that naturally resist bushy dwarf virus may soon be available.

ARS scientists in Corvallis, OR, and Agritope, Inc., of Portland, OR, are genetically modifying the most popular raspberry variety grown in the Pacific Northwest to give the plants this resistance.

The virus causes small, crumbly fruit unsuitable for use as whole berries. Infection spreads rapidly through a field, and growers often must remove the plants, fumigate the soil, and start over every 5-year cycle. That means fewer domestic raspberries and higher costs for consumers.

The scientists are using genetic material from the virus to induce resistance in the raspberry plants. They're trying three strategies to find the best approach.

One interferes with the virus' ability to replicate itself. Another alters and inserts a gene from the virus that prevents its spread from cell to cell. The third would have the plant make a small piece of viral RNA that doesn't make any protein and so becomes targeted by the plant for degradation.

Researchers hope to refine the best strategy and provide breeding lines to growers within 3 years. They should also be able to use the results to incorporate virus resistance into other cultivars of raspberry, blackberry, or black raspberry.

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Distinguishing the good bug from the bad bug just became more precise.

A newly revised catalogue of known stilt bugs worldwide has eliminated previous errors and adds two overlooked species.

True bugs are a common and diverse group of insects that are both pests of crops and beneficial predators. The family Berytidae is a small but diverse group of true bugs that get their common name, "stilt bugs," from the long, slender legs and antennae of many species.

Many stilt bug species have been implicated as pests of crops such as cacao, tobacco, and tomato. But several others are important predators, feeding on aphids, hornworm eggs and larvae, leaf-hoppers, thrips, and other pests.

In February 1998, the ARS true bug experts published a world catalogue of stilt bugs that treated 36 genera and 169 species and contained nearly 200 host-plant records. Since then, feedback from several colleagues has

helped to discover and correct several errors, like minor misspellings and the omission of species, for the forthcoming catalogue of stilt bugs of the Palearctic Region—the geographic region that includes the northwest coast of Africa, Europe, and Asia north of the Himalaya Mountains.

These corrections supplement the world catalogue and include the two overlooked species. This information is of great importance to other researchers, including biocontrol workers who need an accurate, comprehensive summary of the literature treating stilt bugs and their distribution.

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IPM/Biocontrol

A state-of-the-art scanning electron microscope mounting technique that uses low temperature (LT-SEM) may help researchers better understand how parasitic mites like Varroa interact with their bee hosts.

Varroa mites feed on the blood of adult and developing young bees. Parasitized bees may have deformed wings and abdomens and a shorter life span than their unparasitized hivemates.

Because the LT-SEM freezes and captures the Varroa mites on bees at the moment they are parasitizing them, a team of ARS scientists has discovered some intriguing behavioral and morphological patterns.

The technique has shown that Varroa mites may be camouflaging themselves by aligning their setae (tiny hairs) with the hairs on the bee's body. By doing this, they may escape detection when the bee grooms itself or is groomed by another. If this hypothesis is correct, it may be possible to breed bees that more easily detect mites and aid their removal from their bodies.

LT-SEM technology provides an exciting new tool that will be used to reveal the exact types and behavior of mites.

It is already providing valuable new information that could be used to control mites as agricultural pests or to enhance their efficacy as biological control agents.

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A team of plant physiologists is studying a tiny mite as a possible biological control for Canada thistle, a major invasive weed pest in U.S. pastures.

First identified in Europe more than 100 years ago, this mite, *(Aceria anthocoptes)*, was discovered in the United States in 1998, when scientists collected some Canada thistle, (*Cirsium arvense*), on Maryland's Eastern Shore. Preliminary results from a survey of the area and surrounding states indicate the mite is abundant there and specific for Canada thistle.

Under growth-chamber conditions, mite populations on a Canada thistle plant can reach very high levels and cause severe damage. Their presence leads to a reddish-brown discoloration and curling of leaves and spindly growth. They can also transmit plant diseases to the weed.

The mite was identified and characterized using state-of-the-art scanning electron microscope mounting techniques that use low temperature. The scientists hope to learn whether mite populations in the field can be manipulated to significantly curb Canada thistle growth and if the mite can transmit viruses to the weed that could also impede its growth.

A search for viral-infected Canada thistle plants in the areas where they were once reported—Denmark, England, and North Dakota—is under way. The team also plans to further examine the specificity of *A. anthocoptes*.

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The Parkinsonia seed beetle could serve as a biological control agent for the Jerusalem thorn tree, an invasive plant that has spread across rangelands from southern Texas to Arizona and northern Mexico.

ARS researchers have found that the Parkinsonia seed beetle, *Penthobruchus germaini*, may be able to control the spread of this invasive tree, *Parkinsonia aculeata*, by depositing its eggs in the tree's seedpod.

Once the eggs hatch, the larvae burrow into the seeds to feed and complete their development. In field studies, the beetle was found to infest one out of every four seeds in one season.

Since *P. germaini* also develops in the relatively short time period of 48 days, two generations of beetles would be available as biological control agents each year. Its cold tolerance, high egg fertility, and low rate of natural parasitism are also highly desirable attributes. And the tests indicate that the beetle is host-specific to *P. aculeata*.

Preliminary field evaluations in Australia—where *P. germaini* was introduced in 1995— indicate that the beetle is destroying a high percentage of Jerusalem thorn tree seeds there.

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A fungus new to science that may control ragweed has been discovered.

Ragweed, *Ambrosia artemisiifolia*, is a noxious plant that infests thousands of acres of arable land worldwide and causes allergic reaction—often seasonal—in many people.

Its pollen causes many sufferers irritated eyes, runny noses, and general discomfort.

Last year, scientists in Hungary—where ragweed is even more of a problem than in the United States—reported they had found a species of *Septoria* fungus that was pathogenic to ragweed. It causes the leaves to die and kills some plants, probably by entering through their leaf openings, called stomates.

ARS mycologists discovered that the fungus belongs to the asexual genus *Septoria*.

After searching the literature, they determined that this fungal species, also found in the United States, had never been described.

They characterized it using molecular sequencing, named it *S. empambrosia*, described and illustrated it, and showed that it is distinct from three other related known *Septoria* species.

Scientists will use this information to communicate about the new fungus in developing it as a biocontrol agent for ragweed.

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Land managers can now compare lists of noxious weeds from the lower 48 United States and 6 Canadian provinces by logging on to a new section of the University of Montana's "Invaders" web site.

ARS scientists developed the new noxious weed section at the web site: http://invader.dbs.umt.edu/Noxious_Weeds

This tool will help decision-makers prioritize control and research efforts at local and national levels. In addition, they can use the system to predict potential future problems by examining lists from neighboring states or regions. Significant amounts of money and effort could be saved by managing invasive weeds while infestations are still small.

The ARS researchers' next step is to look at weed distributions and how alien weeds have spread over time.

Spotted knapweed, for instance, first entered the Pacific Northwest around 1893. It began to spread more rapidly in the 1950s, but distribution exploded from 60 counties in 1985 to at least 175 today.

The researchers hope to identify reasons for such expansions, as well as trends that can help identify which alien plants pose the most risk of future expansion.

Northern Plains Agricultural Research Laboratory, Sidney, MT
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Bacteria discovered near the roots of sugar beet plants may offer biological alternatives to chemical pesticides for controlling one of this crop's worst fungal enemies.

Ongoing ARS studies have shown that certain strains of *Pseudomonas* root bacteria exude substances that stifle the growth of *Cercospora beticola* fungi. In nature, the bacteria compete with the fungi for space and nutrients on or near sugar beet leaves.

Cercospora causes the sugar beet disease leaf spot, which weakens susceptible cultivars by defoliation.

Grown on 1.5 million acres, sugar beets supply an estimated 50 percent of America's sucrose.

Beets that are somewhat genetically resistant to *Cercospora* have been identified, but they haven't been developed into elite commercial lines. Therefore, beet growers are forced to rely on chemical fungicides to reduce the economic impact of *Cercospora* outbreaks.

Scientists are exploring a more environmental friendly approach using two kinds of *Pseudomonas* bacteria: ND6-2 and ND9L.

One strategy is to mix the bacteria's spores into a so-called biopesticide that could be sprayed onto the beet plant's leaves to prevent *Cercospora* fungal spores from germinating.

Another approach is to isolate genes for the microbe's antifungal compounds and transfer these genes into sugar beets.

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A small, parasitic wasp could play a major role in efforts to improve the quality of U.S. stored commodities.

Stored-product insects can be a major problem in grocery, health food, pet stores, and home pantries. Infested products can include bird seed, peanuts, pecans, dog food, candy, macaroni, breakfast cereals, cornmeal, bread, and dried beans.

Habrobracon hebetor is a beneficial parasitic wasp that attacks the larvae of many agriculturally destructive moths, including the Indianmeal moth—the most damaging insect pest in stored commodities. This moth as well as other insect pests has developed widespread resistance to *Bacillus thuringiensis* (*Bt*), which means pesticides must be used to control them.

New biocontrol methods are needed because insects are also developing resistance to currently available pesticides, and environmental regulations limit the use of others.

Quantities of *H. hebetor* are commercially available for pest management programs, but they would be more economical to mass-produce if artificial diets were available.

ARS researchers described the digestive processes of these parasites as they fed on the blood of Indianmeal moth larvae in the laboratory. Information from this research will aid in the development of artificial diets.

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Plant Genetic Resources

More than 6,000 highly detailed watercolors of apples, blackberries, cherries, grapes, persimmons, and other fruits are part of the USDA Pomological Watercolor Collection.

Located at the National Agricultural Library in Beltsville, MD, the collection is a treasure trove of late 19th- and early 20th-century American botanical illustrations.

Many of these priceless but little-known drawings illustrate varieties that early USDA scientists either developed in their own fruit-breeding programs or collected on overseas expeditions. Farmers learned of the new varieties through USDA bulletins or other publications in which the prints appeared.

Today, the collection serves as an important reference for horticulturists, historians, artists, and publishers. The National Agricultural Library is part of the Agricultural Research Service.

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Computer Systems and Models

Some computer models for predicting agricultural chemicals' movement through soil may need to be revised.

Groundwater can be contaminated when applied chemicals move quickly through wormholes, cracks, and other large fissures in the soil. Computer models used to predict this rapid movement require a lot of information to run properly.

So an ARS scientist has tested methods that can be used to obtain the information needed to run models like the "root zone water quality model," or RZWQM, developed by ARS scientists at Ames, IA.

Effective methods for obtaining input for models include measuring the rate that water moves through unsaturated soil and using image analysis to characterize the size and number of soil holes. Some measurements fell outside the range of the models, indicating that revisions may be needed.

By predicting when groundwater contamination may occur, the models can alert farmers to the need to modify agricultural management practices appropriately.

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The good news is that newly harvested wheat is generally not infested with insects.
The bad news: Insects enter grain bins within 30 days of harvest.

ARS entomologists used traps to monitor 34 grain bins on 12 different Kansas farms. The traps counted insects entering through openings near the roof. Bin sizes ranged from 1,000 to 8,000 bushels. An average of 14 rusty grain beetles, 6 lesser grain borers, 6 foreign grain beetles, and 22 hairy fungus beetles entered these bins each day during the first month of storage.

This information, which can help reduce insect pest management costs, will be added to Stored Grain Advisor (SGA). This is a personal computer model developed to help grain managers select the best timing for control methods.

SGA Pro, developed for use in large grain elevators, is being provided to grain elevator managers in ARS' Kansas-Oklahoma areawide IPM project.

Each year, over 2 billion bushels of wheat are produced in the United States, with most of it being stored at one time or another in an elevator. Stored-grain insect pests such as the lesser grain borer, rice weevil, red flour beetle, and rusty grain beetle cost the U.S. wheat industry about $500 million annually.

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Teacher's Desk — http://www.ars.usda.gov/is/kids/teachers/TeachDesk.htm

Timeline of ag research accomplishments — http://www.ars.usda.gov/is/timeline/index.htm